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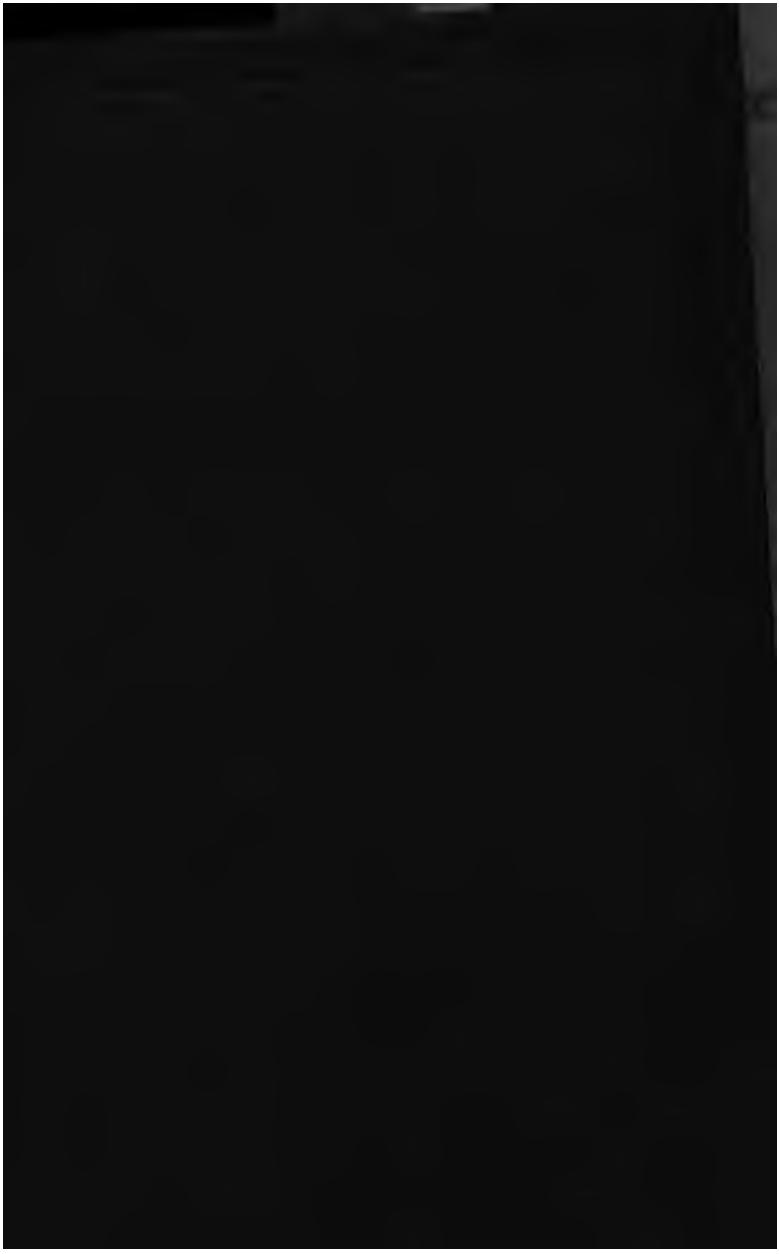
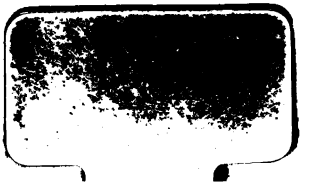




SUPPLEMENTARY ARITHMETIC;

A MANUAL OF

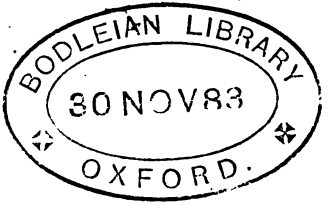
IMPROVED METHODS OF WORKING SOME OF THE MORE ADVANCED RULES,

INCLUDING NUMEROUS EXAMPLES IN PROPORTION, VULGAR FRACTIONS, PER CENTAGES, AVERAGING OF RATES, AND SCALES OF NOTATION.

AND AN APPENDIX OF EXAMINATION PAPERS, WITH ANSWERS.

BY THE

REV. J. HUNTER, M.A.



LONDON:
GEORGE BELL AND SONS, YORK STREET,
COVENT GARDEN.
1883.

181. g. 273.

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
STAMFORD STREET AND CHARING CROSS.

PREFACE.

A LONG course of practical experience, both as a teacher and as an examiner, has made the author of this little manual familiar with some general sources of imperfection and of failure in the higher arithmetical work of schools and public examinations,—sources continuing to occasion the imperfection and the failure, notwithstanding the provision of so many well-planned volumes of Arithmetic, well stored with good examples.

The present publication is an attempt not only to remove such imperfection, and to avert, as far as possible, such failure, but also to follow up with yet further improvement the important contributions of improvement which arithmetical method has from time to time received since the middle of the present century.

A persuasion has for a considerable time existed and been acted upon, that questions such as are proposed under the Rule of Simple Proportion should always be solved by what is called the Unitary Method, rather than according to the long established method of arranging into 1st, 2nd, and 3rd terms, whence the title *Rule of Three* is derived. We dislike the title Rule of Three; for, as a

descriptive phrase, it seems to indicate an artificial dogmatism in which the reasoning employed is merely mechanical. The Unitary Method is undoubtedly preferable as an intellectual and demonstrative system. While, however, we do not allow that the method of *stating* can without much inconvenience be quite discarded, we think the usual procedure of the Unitary Method occupies an amount of space which is often inconvenient; and we have endeavoured in the present work to make much less space contain equally rational and intelligible forms of solution for questions in Proportion and its various branches of application.

In accordance with the title of this work we believe that the peculiar considerations and illustrations which we have introduced regarding Vulgar Fractions will be found very usefully supplementary to what is usually taught concerning that department of Arithmetic.

The old rules of Alligation, with their artificial linking processes, have been very properly omitted from modern treatises; but since the author of this manual, in his 'Modern Arithmetic' (p. 154), called attention to an intellectual method of treating certain useful Alligation problems, questions of the kind have been frequently proposed in Examination Papers in Arithmetic. The subject is here much simplified in the chapter entitled *Averaging of Rates.*

Problems relating to Scales of Notation have also of late years been frequently proposed in arithmetical Examination Papers, although the subject is seldom met with in treatises of Arithmetic,* being

* An excellent chapter on Scales of Notation is given in Elsee's 'Arithmetic.'

usually committed to the care of Algebra. But it can be very easily taught by ordinary Arithmetic; and we have given it a place in this work not only as provision for test Examinations, but on account of its utility in promoting a proper understanding and appreciation of our ordinary decimal system of notation.

For many of those students who are preparing for Civil Service or other public examination, the specimen we have given at p. 51 of a good method of presenting the work of a particular Paper is likely to be of considerable service. But we may here interpose two cautions, which our frequent inspection of the written work of candidates has shown to be in many instances very needful:—

One of the most common faults in their work is a wrong use of the sign of equality: as when, in subtracting $\frac{7}{12}$ from the sum of $\frac{4}{9}$ and $\frac{5}{6}$, the work is done thus: $\frac{4}{9}+\frac{5}{6}=\frac{23}{18}-\frac{7}{12}=$&c., which wrongly asserts the sum of $\frac{4}{9}$ and $\frac{5}{6}$ to be equal to the difference of $\frac{23}{18}$ and $\frac{7}{12}$; the proper form of work is $\frac{4}{9}+\frac{5}{6}=\frac{23}{18}$, hence $\frac{23}{18}-\frac{7}{12}=\frac{25}{36}$; or better as follows:

$$\frac{4}{9}+\frac{5}{6}-\frac{7}{12}=\frac{16+30-21}{36}=\frac{25}{36}.$$

Again: although when mixed fractions are given for multiplication or division, it is generally most convenient to reduce them to improper fractions, many candidates improperly think the same preparation to be expedient in addition and subtraction; but in this case such previous reduction makes very clumsy work: it is a waste of time, and often very irksome to an examiner. Let the student cultivate familiarity with the following better methods:—

(i) $13\frac{5}{12} + 28\frac{7}{8} + 3\frac{4}{9} + \frac{5}{36} = 13 + 28 + 3 + \frac{30 + 63 + 32 + 10}{72} = 44 + \frac{135}{72} = 44 + 1\frac{63}{72} = 45\frac{7}{8}$.

(ii) $41\frac{1}{15} - 23\frac{19}{35} = 18 + \frac{7}{105} - \frac{57}{105} = 18 - \frac{50}{105} = 18 - \frac{10}{21} = 17\frac{11}{21}$.

We may further observe that, in working division of decimals, though the simple method which the author of this work planned some years ago, and described at p. 95 of his 'Modern Arithmetic,' and at p. 60 of his revised edition of 'Colenso's Arithmetic,' has been pretty generally adopted, and was recognised as a useful improvement in the 25th 'Report of the Civil Service Commissioners' (p. 88), it remains still to be learned by many pupils who do not find in other methods so good a safeguard from error in pointing the result.

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ERRATUM.

P. 33, *2nd line from bottom, for* "100 gallons of spirits containing 50 gallons alcohol," *read* "100 gallons composed of equal weights of alcohol and water."

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SUPPLEMENTARY ARITHMETIC.

CHAPTER I.

Meanings of the Fractional Form.

1. A vulgar fraction, strictly so called, is an abstract quantity. Let $\frac{m}{n}$ represent such a quantity: it signifies m times the nth part [of some unit], or the nth part of m times [that unit].

Suppose the fraction to be $\frac{7}{12}$; this fraction, if referred to a *foot* as the unit, signifies 7 times the 12*th* part of a foot, or the 12*th* part of 7 times a foot.

A fraction may be regarded as having a denomination of its own—an abstract one, viz. that of *equal parts*, expressed by what is therefore called the *denominator*; thus $\frac{7}{12}$, taken generally, denotes 7....12*th parts*, or 12*ths*. Compare this with the expressions 5 feet 7 inches and 5*s*. 7*d*.; in the former of these the denomination *inches* means 12*ths* of *a foot*; in the latter the denomination *pence* means 12*ths* of *a shilling*.

2. As the fractional form is also used to signify the division of the upper number by the lower, let us refer to the ordinary Rule of Compound Division for an illustration of this.

The Rule of Division has for its *direct* object, to find *a quotient*, an *abstract* number expressing *how many times* one quantity is contained in, or can be taken from, another of the same kind; as when it is asked how often 6*s.* 3*d.* is contained in 25*s.*; the answer to which is 4 *times;* and accordingly, 4 is with propriety called the *quotient.*

But under the Rule of Division there is included an inquiry of a different kind from the above, as when it is required to find the 4*th part* of 25 *shillings.* Now, here the data are not a divisor and dividend, for the abstract number 4 is not contained in, cannot be subtracted from, 25 shillings; but we have here an indirect kind of division proposed, having to find what quantity is contained 4 times in 25 shillings; we have a quotient *given* and a dividend to find the divisor; the answer is 6*s.* 3*d.*; and this result is not a *quotient*, though commonly called so; it is the *divisor* that is contained 4 times in 25*s.*; and the dividing process is properly this—the 4*th* part of 25*s.* is 6*s.*, leaving 1*s.* over, and the 4*th* part of the shilling is 3*d.*

Now, the fractional form is used to express both kinds of division. Thus we have $\frac{25s.}{6s.\ 3d.} = 4$, and $\frac{25s.}{4} = 6s.\ 3d.$; but the latter form, meaning the 4*th* part of 25*s.*, is not truly a fraction, although it can be made one by detaching from its numerator the denomination of shillings, and substituting the equivalent expression $\frac{25}{4}$ of 1 shilling, that is, 25 times the 4*th* part of 1 shilling. On the other hand, $\frac{25s.}{6s.\ 3d.}$ or $\frac{300 \text{ pence}}{75 \text{ pence}}$, is a fraction, and of abstract

value, for it signifies 4 *times*, and the same value belongs to $\frac{300 \text{ yards}}{75 \text{ yards}}$, and to $\frac{300 \text{ bushels}}{75 \text{ bushels}}$, and to $\frac{300}{75}$ taken generally.

3. Let the student then notice that the expressions $\frac{13s.\ 9d.}{16s.\ 3d.}$ and $\frac{21 \text{ oz. } 9 \text{ dwt.}}{25 \text{ oz. } 7 \text{ dwt.}}$ can be used to represent the same abstract value; that the first though denoted by money does not denote money, and the second though denoted by weight does not signify weight, that the first is equal to $\frac{665}{995}$ and the second to $\frac{429}{607}$, and that each of these is equal to $\frac{11}{13}$.

4. The fractional form, when its upper and lower quantities are of like kind, is also used to signify that fraction which the upper is of the lower. Thus $\frac{13s.\ 9d.}{16s.\ 3d.}$ is equal to that fraction of $16s.\ 3d.$ whose value is $13s.\ 9d.$; for we have found the expression $= \frac{11}{13}$, and as 11 is equal to $\frac{11}{13}$ of 13, so $13s.\ 9d.$ is equal to $\frac{13s.\ 9d.}{16s.\ 3d.}$ of $16s.\ 3d.$

Examples for Practice.

(1) Reduce to its simplest form $\frac{4 \text{ yds. } 2 \text{ ft. } 9 \text{ in.}}{11 \text{ yds. } 1 \text{ ft. } 5 \text{ in.}}$.

Ans. $\frac{3}{7}$.

(2) What fraction of 1 cwt. 72 lb. is 2 cwt. 29 lb.?

Ans. $\frac{11}{8}$.

(3) Express in simple terms the ratio of 26 ac. 1 ro. 18 per. to 58 ac. 3 ro. 5 per. *Ans.* $\frac{74}{165}$.

(4) Simplify $\frac{9 \text{ hrs. } 35 \text{ min. } 3 \text{ sec.}}{5 \text{ da. } 16 \text{ hrs. } 2 \text{ min.}}$. *Ans.* $\frac{31}{440}$.

(5) Calculate $\frac{4 \text{ cwt. } 3 \text{ qrs. } 12 \text{ lb.}}{2 \text{ tons } 15\frac{1}{4} \text{ cwt.}}$ of £8 10*s.* $7\frac{1}{2}d.$ *Ans.* 15*s.*

(6) Divide 43 quarters 2 bushels $2\frac{1}{2}$ pecks by $\frac{12s.\ 8\frac{3}{4}d.}{£2\ 15s.\ 3d.}$. *Ans.* 188 qu. 2 pks.

(7) Find the simple value of $\frac{32}{45}$ of $\frac{5}{8}$ of $\frac{5s.}{8d.}$ of $\frac{5s.}{8}$. *Ans.* 2*s.* 1*d.*

(8) Reduce 5 gall. $3\frac{1}{3}$ qts. to the fraction of 10 gall. 3 qts. $1\frac{1}{2}$ pt. *Ans.* $\frac{8}{15}$.

(9) Find the value of $\frac{10 \text{ oz. } 9 \text{ dwt.}}{14 \text{ oz. } 12 \text{ grs.}}$ of £3 12*s.* 3*d.* *Ans.* £2 13*s.* 10*d.*

(10) What ratio has 17 yds. 2 ft. $7\frac{1}{2}$ in. to 5 yds. 3 qrs. $2\frac{1}{4}$ na.? *Ans.* $\frac{88}{99}$.

(11) Find the value of $\frac{20}{63}$ of $\frac{13 \text{ ft. } 5 \text{ in.}}{10\frac{1}{2} \text{ ft.}}$ of $\frac{£6\ 15s.}{23}$. *Ans.* 2*s.* $4\frac{4}{7}d.$

(12) Find the value of $\frac{5}{11}$ of $\frac{76 \text{ sq. ft. } 45 \text{ in.}}{31\frac{1}{4} \text{ sq. yds.}}$ of $\frac{24s.\ 2d.}{1s.\ 6\frac{1}{2}d.}$. *Ans.* $1\frac{14}{15}$.

(13) A's age is 11 yrs. 3 mths., B's 15 yrs. 9 mths., and C's age is 18 yrs. 9 mths. What ratio does A's age bear to B's? and what ratio does C's bear to A's? *Ans.* $\frac{5}{7}$; $\frac{5}{3}$.

(14) Multiply $\frac{34 \text{ sq. po. } 17 \text{ yds.}}{23 \text{ sq. po. } 21 \text{ yds. } 2\frac{1}{4} \text{ ft.}}$ by $\frac{4}{5}$ of $\frac{14s.\ 11\frac{1}{4}d.}{£4\ 12s.\ 3d.}$. *Ans.* $\frac{17}{30}$.

(15) From $1\frac{120}{121}$ subtract $\frac{17 \text{ ac. } 31 \text{ po.}}{17 \text{ ac. } 1 \text{ ro. } 12 \text{ po.}}$

Ans. $\frac{1}{1}\frac{4}{4}\frac{8}{5}\frac{1}{2}$.

(16) Simplify $\frac{12 \text{ ac. } 1 \text{ ro. } 1 \text{ po.}}{86\frac{1}{3} \text{ ac.}} - \frac{339\frac{1}{5} \text{ lb.}}{26\frac{1}{4} \text{ cwt.}}$.

Ans. $\frac{2}{3}\frac{3}{2}$.

(17) Find in simplest terms the sum of $\frac{\frac{3}{7} \text{ of half-a-crown}}{\frac{5}{8} \text{ of a guinea}} + \frac{\frac{4}{5} \text{ of a foot}}{\frac{7}{9} \text{ of a yard}}$. *Ans.* $\frac{1}{2}\frac{0}{4}\frac{4}{5}$.

(18) Find the value of $\frac{10s.}{63} + \frac{3\frac{3}{10}}{6\frac{1}{8}}$ of $\frac{£11\frac{1}{2}}{£12\frac{3}{8}}$ of $\frac{£14\frac{1}{7}}{46}$. *Ans.* $3s.\ 2\frac{1}{1}\frac{4}{5}d.$

(19) Simplify

$$\frac{\frac{4}{5} \text{ of } \frac{2\frac{1}{7}}{3\frac{1}{8}} \text{ of a ton} + \frac{3}{7} \text{ of } \frac{5}{8} \text{ of } 2\frac{2}{9} \text{ cwt.}}{30\frac{1}{8} - 8\frac{1}{7} - 7\frac{1}{8}}.$$

Ans. $\frac{1}{1}\frac{0}{3}\frac{0}{1}$ of a cwt.

(20) Simplify

$$\frac{15\frac{9}{14}}{20\frac{5}{8}} \text{ of } \frac{31 \text{ yds. } 2 \text{ ft. } 8 \text{ in.}}{51\frac{1}{2} \text{ yds.}} \text{ of } \frac{31\frac{1}{2} \text{ yds.}}{32} + \frac{16 \text{ ft. } 11 \text{ in.}}{\frac{3}{8} + \frac{1}{8}}.$$

Ans. 8 yds. $8\frac{4}{7}$ in.

CHAPTER II.

Proportion.

1. It is expedient that questions in Simple Proportion should most frequently be worked by a method which we proceed to exemplify, avoiding the formality of the usual arrangement into 1st, 2nd, and 3rd terms, and at the same time requiring less space than the usual style of the unitary method, from which, however, it is derived.

Ex. (1) If 18 oz. of tobacco be worth 6*s.* 9*d.*, how much of it is worth 5*s.* 3*d.*?

From what has been shewn in the preceding chapter, it is easily reasoned, that the value of the weight sought is $\frac{5s.\ 3d.}{6s.\ 9d.}$ of the value of the weight given; hence we may write at once

$$\frac{5s.\ 3d.}{6s.\ 9d.} \text{ of } 18 \text{ oz.} = \frac{18 \text{ oz.} \times 63}{81} = \frac{18 \text{ oz.} \times 7}{9} = 14 \text{ oz. } \textit{Ans.}$$

Ex. (2) What is a gentleman's gross income, when he has to pay £9 12*s.* 10½*d.* income tax, at the rate of 5*d.* in the pound?

The whole gross income contains £1 of gross income as often as the whole amount of the tax contains 5*d.*; therefore it is

$$\frac{192s.\ 10\frac{1}{2}d.}{5d.} \text{ of } £1 = \frac{£2314\frac{1}{2}}{5} = £462\ 18s. \textit{ Ans.}$$

Ex. (3) If a person's nett income be £1306 10*s.* after paying an income tax of 6*d.* in the pound, what is his gross income?

The whole gross income contains £1 of gross income as often as the whole nett income contains 19*s.* 6*d.* of nett income; therefore it is

$$\frac{£1306\ 10s.}{19s.\ 6d.} \text{ of } £1 = \frac{£2613 \times 20}{39} = £1340. \textit{ Ans.}$$

Ex. (4) How much water must be mingled with 15 gallons of spirits worth 19*s.* 6*d.* a gallon, to reduce the price to 18*s.* a gallon?

The number of diluted gallons at 18*s.* must amount to the same total value as the 15 gallons at 19*s.* 6*d.*, and therefore must be as many as the number of times that 19*s.* 6*d.* × 15 contains $18s. = \frac{19\frac{1}{2}s.}{18s.}$ of 15 gall. = $1\frac{1}{12}$ of 15 gall.; hence the water added = $\frac{1}{12}$ of 15 = $1\frac{1}{4}$ gall. *Ans.*

2. The preceding question is commonly worked by first finding how many gallons at 18*s.* are equivalent to 15 gallons at 19*s.* 6*d.*, and then subtracting the 15 from the result. It forms an example of what is called Inverse Proportion, and suggests some reference here to those inverse questions, so often proposed, in which two different numbers of men are compared with the different periods they require for the performance of a piece of work. The number of men does not vary directly as the time, but inversely. If 3 men take 5 days, twice 3 men do not take twice 5 days, but half of 5 days. The *direct* comparison is between the numbers of men and the amounts of work they do in the same

time. Let us take this into consideration in working two examples.

Ex. (5) If 12 men could perform a piece of work in 5 hours, how many men could do it in 4 hours?

This is plainly equivalent to asking how many men could do $\frac{1}{4}$ of a piece of work in an hour, when 12 men could do $\frac{1}{5}$ of it in an hour; or how many men do $\frac{5}{20}$, when 12 men do $\frac{4}{20}$; and so we have $\frac{5}{4}$ of 12 = 15 men. *Ans.*

Ex. (6) If 14 men could perform a piece of work in $4\frac{1}{2}$ days, in how many days could 12 men do it?

Here again we may make the analogy direct, by asking what portion of the work 12 men could do in a day, when 14 men do $\frac{1}{4\frac{1}{2}}$ or $\frac{2}{9}$ of it in a day; and so we have $\frac{12}{14}$ of $\frac{2}{9}$, or $\frac{4}{21}$, or $\frac{1}{5\frac{1}{4}}$ of the work in a day, and hence the whole of the work in $5\frac{1}{4}$ days. *Ans.*

*** The student should notice the following equivalents:—

12 men for 5 hours $\begin{cases} = 1 \text{ man for } 12 \text{ times } 5 \text{ hours.} \\ = 5 \text{ times } 12 \text{ men for } 1 \text{ hour.} \end{cases}$

3. A very common class of questions is that in which agencies of different power are compared in relation to the different times in which they can perform the same amount of work.

Ex. (7) A can perform in 5 hours a piece of work which B could do in 4 hours. In what time could A and B together do it?

Here it may be observed that the times of A and B are the times assigned in Ex. (5) to 12 men and 15 men, respectively; and if, after finding 15 men as the answer in that example, we had to find the time in which the 12 men and 15 men together could do the work, we should reason that, as the 12 men do $\frac{1}{5}$ of the work in an hour, the 27 men would do $\frac{27}{12}$ of $\frac{1}{5}$, or $\frac{9}{20}$, of the work in an hour, and, consequently, the whole $\frac{20}{20}$ in $\frac{20}{9}$, or $2\frac{2}{9}$ hrs.

But, to solve the present question in the customary way,—we say, A in 1 hour does $\frac{1}{5}$ of the work, and B in 1 hour does $\frac{1}{4}$, and hence A and B together do $\frac{1}{5}+\frac{1}{4}=\frac{9}{20}$ of the work in 1 hour, or the whole $\frac{20}{20}$ in $\frac{20}{9}$ or $2\frac{2}{9}$ hrs. *Ans.*

To promote, however, both convenience and neatness in the solution of such problems, and, especially, to facilitate the solution of some of the harder problems of this class, we recommend as a superior method that which we shall now apply to the preceding question.

As the times of A and B are 5 and 4, take 20 the L.C.M. of these numbers, to denote a number of equal parts of which the whole work consists.

A does $20 \div 5$ or 4 parts per hour, B $20 \div 4$ or 5 parts per hour; $\therefore$ A and B together do 9 parts per hour; and hence they will do the whole in $20 \div 9 = 2\frac{2}{9}$ hrs. *Ans.*

We shall add a few more examples in further illustration of this method.

Ex. (8) A can do a piece of work in $17\frac{1}{2}$ days, which A and B together can do in $9\frac{1}{3}$ days. In what time could B by himself do it?

Take any common multiple of $17\frac{1}{2}$ and $9\frac{1}{3}$,—say

138 their L.C.M., as the number of equal parts for the whole work. A does $138 \div 17\frac{1}{4}$, or 8 parts in 1 day, A and B together do $138 \div 9\frac{1}{5}$, or 15 parts in 1 day; hence B does $15 - 8$ or 7 parts in 1 day, and, consequently, the whole 138 parts in $19\frac{5}{7}$ days. *Ans.*

Ex. (9) A certain amount of work is to be performed jointly by A, B, and C. The whole would be done by A alone in 21 days, by B alone in 24, and by C alone in 28. If A begins the work 6 days before he is joined by B, and 10 days before he is joined by C, in what time will the whole work be done?

Take 168, the L.C.M. of 21, 24, and 28, as the number of equal parts in the whole work; A does $168 \div 21 = 8$ parts in a day, B $168 \div 24 = 7$, C $168 \div 28 = 6$.

Before C begins, A has done $8 \times 10 = 80$ parts,

B „ $7 \times 4 = 28$ „

$168 - 108 = 60$ parts

remaining to be done by A, B, C, together, at the rate of $8 + 7 + 6$, or 21 parts per day; $\therefore 60 \div 21 = 2\frac{6}{7}$ days, the time when all three worked together; hence $10 + 2\frac{6}{7} = 12\frac{6}{7}$ da. *Ans.*

Ex. (10) If the work referred to in the preceding question had been done by A, B, and C, all working together, with the exception of C going away 2 days before the work was completed, how long would the work have lasted?

If C had worked during those 2 days of absence, he would have added $6 \times 2 = 12$ parts to the whole

work, making it amount to $168+12=180$ parts, which would have been done by A, B, and C, in $180 \div (8+7+6)=8\frac{4}{7}$ days. *Ans.*

4. Our mode of solving questions in Simple Proportion can be easily extended to questions in Compound Proportion.

Ex. (11) If 2470 cubic yards of clay can be dug out in 6 days by 39 labourers, working $9\frac{1}{2}$ hours a day, how many cubic yards can be dug in 10 days by 37 labourers, working 9 hours a day?

$$2470 \text{ c. yds.} \times \frac{10 \text{ da.}}{6 \text{ da.}} \times \frac{37 \text{ lab.}}{39 \text{ lab.}} \times \frac{9 \text{ hrs.}}{9\frac{1}{2} \text{ hrs.}}$$

$$= \frac{2470 \text{ c. yds.} \times 5 \times 37 \times 18}{3 \times 3 \times 13 \times 19} = 10 \text{ c. yds.} \times 5 \times 37 \times 2$$

$$= 3700 \text{ cub. yds.} \quad \textit{Ans.}$$

Ex. (12) If a trench that is 108 yards long, $4\frac{1}{4}$ feet wide, and $3\frac{3}{4}$ feet deep, be cut by 15 men in $13\frac{1}{2}$ hours, in what time can one that is 119 yards long, 5 feet wide, and 3 feet deep, be cut by 21 men?

$$13\tfrac{1}{2} \text{ hrs.} \times \frac{119 \text{ yds.}}{108 \text{ yds.}} \times \frac{5 \text{ ft.}}{4\frac{1}{4} \text{ ft.}} \times \frac{3 \text{ ft.}}{3\frac{3}{4} \text{ ft.}} \times \frac{15 \text{ m.}}{21 \text{ m.}}$$

$$\frac{27 \text{ hrs.} \times 119 \times 20 \times 12 \times 5}{2 \times 108 \times 17 \times 15 \times 7} = 10 \text{ hrs.} \quad \textit{Ans.}$$

5. As the form $\frac{m}{n}$, when signifying m divided by n, is often changed to $m \div n$, so when it denotes *ratio*, it is often changed to $m : n$. Thus, if A has $10\frac{1}{2}d.$, and B has $8\frac{1}{4}d.$, we express the ratio of A's

money to B's by writing, A's is $\frac{14}{11}$ of B's, or A's is to B's as 14 : 11, that is, 14 to 11.

Now, three or more quantities may be compared, at once, in a similar manner. Thus, when we say that the capitals of three partners are as 3 : 5 : 9, we mean that A's capital is equal to $\frac{3}{5}$ of B's, and B's equal to $\frac{5}{9}$ of C's. Moreover, as the sum of the proportional numbers, 3, 5, 9, is 17, we are thus shown that A has $\frac{3}{17}$ of the joint capital, B $\frac{5}{17}$, and C $\frac{9}{17}$. Let us apply such consideration to some examples in what is called Proportional Parts, or Distributive Proportion.

Ex. (13) Divide the number 65 into two parts as 16 : 23, that is, so that the 1st shall be equal to $\frac{16}{23}$ of the 2nd.

The 1st is $\frac{16}{39}$ of the whole, the 2nd is $\frac{23}{39}$; hence, $\frac{65}{39}$, or $\frac{5}{3}$, × 16, and × 23, gives $26\frac{2}{3}$ and $38\frac{1}{3}$. *Ans.*

Ex. (14) Three sisters are to share 5 guineas among them in proportion to their ages, which are 9, 12, and 14 years: what sum will each have?

The 1st will have $\frac{9}{35}$, the 2nd $\frac{12}{35}$, and the 3rd $\frac{14}{35}$ of the whole; hence $\frac{105s.}{35}$, or 3*s.*, × 9, 12, 14, severally gives 27*s.*, 36*s.*, 42*s.* *Ans.*

Ex. (15) Find three numbers together amounting to 1070, so that 5 times the 1st may be equal to 6 times the 2nd, and to 7 times the 3rd.

Here the 2nd is $\frac{1}{6}$ of 5 times the 1st, or is $\frac{5}{6}$ of the 1st, and the 3rd is $\frac{1}{7}$ of 5 times the 1st, or is $\frac{5}{7}$ of the 1st; so that the numbers are as 1 : $\frac{5}{6}$: $\frac{5}{7}$, or as

42 : 35 : 30, sum, 107; hence $\frac{1070}{107}$, × 42, 35, 30, severally, gives 420, 350, and 300. *Ans.*

Ex. (16) What period of time can be divided into three such portions, that the first shall be $\frac{7}{8}$ of the 2nd, and the 2nd $\frac{6}{7}$ of the 3rd, and the 3rd 35 days longer than the 1st?

Here, for every 7 days in the 3rd portion there are 6 in the 2nd, and $\frac{7}{8}$ of 6, or $5\frac{1}{4}$, in the 1st. Accordingly, the times are as $5\frac{1}{4}$: 6 : 7, or as 21 : 24 : 28; sum, 73. Thus the 3rd is seen to be longer than the 1st by $\frac{7}{73}$ of the whole period; but it is given longer by 35 days; therefore the whole period is equal to 35 da. $\div \frac{7}{73} = 365$ days. *Ans.*

Examples for Practice.

(1) If 21 yards cost a certain sum, what will 28 yards cost? *Ans.* $\frac{4}{3}$ of the sum.

(2) When 12 gallons have a given weight, what is the weight of 10 gallons? *Ans.* $\frac{5}{6}$ of the given weight.

(3) If 65 men can do a piece of work in a certain time, how long would 45 men take to do it? *Ans.* $1\frac{3}{9}$ of the time.

(4) A certain number of men are necessary to finish a piece of work in $11\frac{3}{8}$ days; how many men would be necessary to finish it in $9\frac{3}{4}$ days? *Ans.* $1\frac{1}{6}$ of the number.

(5) If a given extent of paving costs £8 13*s.* 3*d.*, how much of it amounts to $4\frac{1}{2}$ guineas? *Ans.* $\frac{6}{11}$.

(6) If 15 lb. cost 65*s.*, what will 28 lb. cost? *Ans.* £6 18*s.* 4*d.*

(7) What time will 16 men take to do an amount of work that 18 men can do in 24 days? *Ans.* 27 da.

(8) How many yards can be got for 15*s.* 7*d.*, at the rate of 38*s.* 6*d.* for 21 yards? *Ans.* 8½ yds.

(9) How many navvies are necessary to excavate 2000 cubic feet of earth in 1 hr. 48 min., if 27 navvies would require 2 hr. 36 min.? *Ans.* 39 nav.

(10) If 2 cwt. 3 qrs. 14 lb. of sugar be worth £3 19*s.* 4*d.*, what quantity is worth £9 7*s.*? *Ans.* 6 cwt. 3 qrs. 3 lb.

(11) The liabilities of a bankrupt amount to £1096 18*s.* 8*d.*, and his assets to £308 10*s.* 3*d.*; how much can he pay in the pound? *Ans.* 5*s.* 7½*d.*

(12) The assets of a bankrupt are £16842 19*s.* 3*d.*, and yield 5*s.* 7*d.* in the pound; what is the amount of his liabilities? *Ans.* £60333.

(13) What quantity of corn is consumed by 35 horses in 10 days, if 25 of them consume 3456 lb. in 10½ days? *Ans.* 4608 lb.

(14) If 6 horses eat 221 stone of hay in 16¼ days, in what time will 10 horses eat 527 stone? *Ans.* 23¼ days.

(15) If 25 umbrellas, each worth a guinea, be sold at a reduced price for £25 2*s.* 3*d.*, how many worth 15*s.* each would bring £14 7*s.* if sold at the same rate of reduction? *Ans.* 20.

(16) If 54 days' interest on £3450 would pay the uniform wages of 14 men for 6 days, how many days' interest on £18630 would pay the wages of 18 men for 21 days? *Ans.* 45 da.

(17) If 144 men can do 1327 cubic yards of trenching in $9\frac{3}{4}$ hours, how many men could do $\frac{3}{4}$ of the work in $8\frac{1}{8}$ hours? *Ans.* $129\frac{3}{5}$ men.

(18) If 14 men in $22\frac{1}{2}$ hours can form a trench 91 yards long, $4\frac{3}{4}$ feet wide, and $3\frac{3}{4}$ feet deep, when the ground is of 4 degrees of hardness, how many men in 12 hours could form a trench 76 yards long, $4\frac{1}{3}$ feet wide, and $4\frac{1}{2}$ feet deep, when the ground is of 3 degrees of hardness? *Ans.* 18 men.

(19) A draper sells 136 yards of silk for £28 18*s.* 6*d.*, when it costs him £9 15*s.* per piece of 51 yards; what sum must he obtain for 126 yards of silk that costs him £10 per piece of 54 yards, if he is to gain at the same rate? *Ans.* £25 19*s.* 2*d.*

(20) Divide £10 among three persons in the proportion 5 : 8 : 12. *Ans.* £2, £3 4*s.*, £4 16*s.*

(21) Two numbers are in proportion as $\frac{5\frac{1}{3}}{5\frac{3}{5}}$ to $\frac{6\frac{2}{3}}{4\frac{3}{8}}$, and their sum is 143; find them. *Ans.* 55, 88.

(22) Divide 9*s.* 3*d.* into three parts, which shall be to each other as 9*s.* 3*d.*, 10*s.* 6*d.*, and 11*s.* 1*d.* *Ans.* 2*s.* $9\frac{3}{10}d.$, 3*s.* $1\frac{4}{5}d.$, 3*s.* $3\frac{9}{10}d.$

(23) A house and its furniture together cost £1600, the cost of the furniture being equal to $\frac{7}{25}$ of that of the house; what was the cost of each? *Ans.* £1250, £350.

(24) Divide 87 guineas among A, B, C, D, so that B's share may equal $\frac{2}{5}$ of A's, C's $\frac{2}{5}$ of B's, and D's $\frac{2}{5}$ of C's. *Ans.* £56 5*s.*, £22 10*s.*, £9, £3 12*s.*

(25) Find three numbers of square yards as 8 : 5 : 14, having the sum of the greatest and least equal to a square pole. *Ans.* 11, $6\frac{7}{8}$, $19\frac{1}{4}$ sq. yds.

(26) What number is such that, if it be divided into three parts as $1 : 23\frac{4}{5} : 67\frac{8}{9}$, the greatest part shall exceed the least by 350? *Ans.* 485.

(27) Find three numbers as 15 : 21 : 28, so that the greatest may be 40 less than the sum of the others. *Ans.* 75, 105, 140.

(28) Divide 218 into 4 parts, so that the first may be equal to $\frac{11}{16}$ of the second, the second equal to $\frac{12}{17}$ of the third, and the third equal to $\frac{13}{18}$ of the fourth. *Ans.* $29\frac{17}{29}$, $43\frac{1}{29}$, $60\frac{28}{29}$, $84\frac{12}{29}$.

(29) I dig one half of my garden in 63 hours, my son digs the other half in 49 hours; in what time could we dig the whole of it, working together? *Ans.* 55 hrs. $7\frac{1}{2}$ min.

(30) A certain quantity of plain sewing can be finished by one woman in 12 hours, by another in $13\frac{1}{2}$ hours; in what time would it be finished by both working together? *Ans.* $6\frac{6}{17}$ hrs.

(31) If A can do in 20 days an amount of work which B can do in 18 days, and C in 15, in what time would it be done by the three working together? *Ans.* $5\frac{25}{31}$ days.

(32) A man can dig a piece of ground in 10 hours, which with his son's assistance he could dig in 5 hrs. 20 min. In what time could the son do the whole work himself? *Ans.* $11\frac{3}{7}$ hrs.

(33) In what time could A perform a piece of work which B could do in $9\frac{1}{6}$ days, C in 11 days, and A, B and C, together in $3\frac{1}{8}$ days? *Ans.* $8\frac{1}{3}$ days.

(34) Three agents by their joint operation can perform a piece of work in 7 hrs. 33 min. 20 sec.; the first alone would take 20 hrs. 24 min. to do the whole, but the second would require $25\frac{1}{2}$ hours; what time would the third take? *Ans.* 22 hrs. 40 min.

(35) A certain amount of work is to be done by A, B and C; the whole would be done by A alone in 36 hours, by B in 45 hours, by C in 40 hours; what time will the whole work occupy, if B begin 3 hours after A, and C an hour later than B? *Ans.* $15\frac{4}{9}$ hrs.

(36) A, B and C begin together a piece of work which A by himself could do in 39 hours, B in 48 hours, C in 52 hours; but A leaves the work 10 hours before it is completed, and C leaves 3 hours before the completion. What time does the whole work occupy? *Ans.* 20 hrs.

CHAPTER III.

Simple Interest and Present Worth.

1. Questions in Simple Interest are chiefly of four kinds :—

i. Given, the principal, the yearly interest on 100, and the time ; to find the whole interest on the principal.

ii. Given, the principal, its whole interest, and the time ; to find the yearly interest on 100.

iii. Given, the principal, its whole interest, and the yearly interest on 100, to find the time.

iv. Given, the sum to which the principal finally amounts, the time, and the yearly interest on 100, to find the principal.

Note.—It will assist the young student if what is usually called *the rate per cent. per annum* be thought of as *the yearly interest on* 100.

2. Now, all the above cases are best dealt with according to the method of working recommended in the preceding chapter. Let us illustrate this by an example of each.

Ex. (1) What is the simple interest on £350 for 3 years, at 4 per cent. per annum?

Total interest on £100 = £12 ;

∴ ditto on £350 = $\frac{350}{100}$ of £12 = 42. *Ans.*

Ex. (2) At what rate per cent. per annum will £350 produce £42 simple interest, in 3 years?

Yearly interest on £350 $= \frac{£42}{3}$;

$\therefore$ ditto on £100 $= \frac{100}{350}$ of $\frac{£42}{3} =$ £4. *Ans.*

Ex. (3) In what time will £350 produce £42 simple interest, at 4 per cent. per annum?

Time for £100 to produce £42 $= \frac{£42}{£4}$ of 1 year;

$\therefore$ ditto for £350 $= \frac{100}{350}$ of $\frac{42}{4} = 3$ years. *Ans.*

Ex. (4) What principal will amount to £392 by simple interest in 3 years, at 4 per cent. per annum?

Principal amounting to £112 = £100;

$\therefore$ ditto amounting to £392 $= \frac{392}{112}$ of £100 = £350. *Ans.*

3. When not the interest but the amount by interest is required, we either may first find the interest, and then add it to the principal, or may at once proceed as in the following example:

Ex. (5) Find the amount of £350 by simple interest a 4 per cent. per annum, for 3 years.

Amount of £100 = £112;

$\therefore$ amount of £350 $= \frac{350}{100}$ of £112 = £392. *Ans.*

4. When the principal and amount are both given, then, instead of dealing with their difference, which is the total interest, we may proceed as in the next example.

Ex. (6) At what rate per cent. per annum will £350 amount to £392, by simple interest, in 3 years?

Amount of £350 = £392;

∴ amount of £100 = $\frac{100}{350}$ of £392 = £112;

hence £12 is the interest on £100 for 3 years = 4 per cent. per annum. *Ans.*

*** *Compare* Ex. (2) above. The student should make himself familiar with both the methods.

5. The 4th of the above examples anticipates the Rule of Present Worth, and might have been proposed thus:—

What is the present worth of £392, payable 3 years hence, interest being at 4 per cent. per annum?

£42 is the true discount that reduces the anticipated future payment £392 to the equivalent present payment £350.

The mercantile or customary discount on £392 is a deduction of the interest on £392 for 3 years at 4 per cent. per annum, which is £47 0*s.* 9·6*d.*

6. Mercantile discount exceeds the true by the interest on the true. Thus, interest on £42 for 3 years at 4 per cent. per annum = $\frac{42}{100}$ of £12 = £5 0*s.* 9·6*d.*, which, added to the true discount, makes the mercantile.

This doctrine may be proved generally as follows:—

If R denote the whole interest on 100, then the mercantile discount, or interest, on £1 is to the true discount on £1 as $\frac{1}{100}$ is to $\frac{1}{100 + R}$, or as 100 + R : 100; which shows that interest exceeds discount by the interest on the discount.

Ex. (7) Find the true discount on £437, payable $2\frac{1}{2}$ years hence, interest being at the rate of 6 per cent. per annum.

Whole interest on 100 = $6 \times 2\frac{1}{2} = 15$; ∴ discount on £115 = £15; and ∴ discount on £437 = $\frac{437}{115}$ of £15 = $\frac{19}{5}$ of £15 = £57. *Ans.*

Ex. (8) What is the present worth of £74 10*s.*, due in 9 months, at $3\frac{1}{2}$ per cent. per annum?

Whole interest on 100 = $\frac{3}{4}$ of $3\frac{1}{2} = 2\frac{7}{16}$; ∴ P. W. of £$102\frac{7}{16}$ = £100; and ∴ P. W. of £$74\frac{1}{2} = \frac{74\frac{1}{2}}{102\frac{7}{16}}$, or $\frac{149 \times 8}{1639}$, or $\frac{8}{11}$ of £100 = £72 14*s.* $6\frac{6}{11}$*d.* *Ans.*

Examples for Practice.

(1) Find the simple interest on £178 10*s.* 10*d.* for $4\frac{1}{2}$ years, at 5 per cent. per annum.
Ans. £40 3*s.* $5\frac{1}{4}$*d.*

(2) What is the simple interest on £1560 for 128 days, at $3\frac{3}{4}$ per cent. per annum?
Ans. £20 10*s.* $3\frac{45}{73}$*d.*

(3) Find the amount, by simple interest, of £171 in $3\frac{1}{2}$ years, at $3\frac{1}{3}$ per cent. per annum.
Ans. £190 19*s.*

(4) At what rate per cent. per annum, simple interest, will £297 yield £40 16*s.* 9*d.* in $2\frac{1}{2}$ years?
Ans. $5\frac{1}{2}$.

(5) Find the amount, by simple interest, of £1308 15*s.* for 8 months, at $4\frac{1}{2}$ per cent. per annum.
Ans. £1348 0*s.* 3*d.*

(6) In what time will £109 12*s.* 8*d.* bear £13 4*s.* 1*d.* simple interest, at $3\frac{1}{8}$ per cent. per annum? *Ans.* 4 years.

(7) What would be the simple interest on £2950 for 3 years 55 days, at $3\frac{1}{8}$ per cent. per annum? *Ans.* £297 8*s.* 6*d.*

(8) Find the amount of £960 12*s.* 9*d.*, by simple interest, in 5 years 4 months, at $3\frac{1}{4}$ per cent. per annum. *Ans.* £1127 2*s.* 11·52*d.*

(9) Calculate the simple interest on £260, from January 7th to September 12th, in a leap year, at 4 per cent. per annum. *Ans.* £7 1*s.* $10\frac{3}{4}d.$ +

(10) Find the amount, by simple interest, of £536 11*s.*, from the 16th of June, in a leap year, to the 14th of March following, at $7\frac{1}{2}$ per cent. *Ans.* £566 8*s.* 6·66*d.*

(11) What principal will amount to £94 6*s.*, by simple interest, at $4\frac{1}{8}$ per cent. per annum, in $4\frac{1}{3}$ years? *Ans.* £80.

(12) At what rate will £2115 amount to £2400 10*s.* 6*d.*, by simple interest, in 6 years?
Ans. $2\frac{1}{4}$ per cent.

(13) What principal will amount to £218 14*s.* $3\frac{1}{4}d.$ in $4\frac{1}{2}$ years, at 5 per cent. per annum, simple interest?
Ans. £178 10*s.* 10*d.*

(14) In what time will £65 12*s.* $9\frac{11}{13}d.$ amount to £68 16*s.*, by simple interest, at $5\frac{1}{4}$ per cent. per annum? *Ans.* 11 months.

(15) In how many days will £1174 7*s.* 6*d.* amount to £1186 4*s.* 3½*d.*, by simple interest, at 4 per cent. per annum? *Ans.* 92 da. (91·95 +).

(16) At what rate per cent. per annum would £57 15*s.* 10*d.* yield £1 8*s.* 6*d.*, simple interest, in 240 days? *Ans.* 3¾ per cent.

(17) What principal will amount to £10 15*s.* 7*d.* in 86 days, by simple interest, at 3⅓ per cent. per annum? *Ans.* £10 13*s.* $11\frac{4}{23}\frac{8}{1}d.$

(18) At what rate per cent. per annum, simple interest, would any sum of money double itself in 23 years 28 days? *Ans.* 4⅓.

(19) The simple interest on a certain sum for 2⅔ years, at 3¾ per cent. per annum, is equal to £150 less than the principal. Find the principal.
Ans. £166 13*s.* 4*d.*

(20) What is the true discount on £111 16*s.* payable 1½ year hence, at 5 per cent. per annum?
Ans. £7 16*s.*

(21) Find the present worth of £33 19*s.* 11*d.*, due 2⅓ years hence, at 4 per cent. per annum.
Ans. £31 1*s.* 10½*d.*

(22) What is the mercantile, and what is the true discount on £13 6*s.*, due 7 months hence, at 5 per cent. per annum? *Ans.* 7*s.* $9\frac{1}{10}d.$; 7*s.* $6\frac{6}{13}d.$

(23) What present payment is equivalent to a payment of £385 16*s.* postponed 5¾ years, if the use of money be worth 3¼ per cent. per annum?
Ans. £320.

(24) Find the mercantile discount, and also the true discount, on £865, payable 9 months hence, at $3\frac{5}{8}$ per cent. per annum. *Ans.* £23 10*s.* $4\frac{1}{8}d.$; £22 17*s.* $10\frac{1}{8}d.$

(25) What is the annual rate of interest, when the true present worth of £462 13*s.* for 5 months is £456. *Ans.* $3\frac{1}{2}$ per cent.

(26) The sum of £2795 4*s.* 4*d.* is payable on the 3rd of December; what is its true cash value on the 17th of August preceding, at $3\frac{1}{3}$ per cent. per annum? *Ans.* £2767 18*s.* 4*d.*

(27) For how many days would £105 15*s.* $11\frac{7}{23}d.$ be the present worth of £107, if the rate of interest were 5 per cent per annum. *Ans.* 83 da.

(28) At what rate per cent. per annum, and for how many years, will the simple interest on £2700 be £220 10*s.*, if the number expressing the rate be half as much again as that expressing the number of years? *Ans.* $3\frac{1}{2}$ per cent. for $2\frac{1}{3}$ yrs.

CHAPTER IV.

General or Absolute Percentages.

1. To what has been said respecting rates per cent. *per annum*, may be added some illustration of per centages that are not strictly referred to time.

The methods of calculation, however, will here be similar to those already exemplified.

We would now have the student familiar with five principal processes:—

i. That of finding the value of a given rate per cent. on a given quantity.

ii. That of finding the rate per cent. by which a given number is changed to another given number.

iii. That of finding what a given quantity will become, if increased or diminished by a given rate per cent.

iv. That of finding the original quantity that has become changed to a given greater or less quantity by a given per centage rate of increase or diminution.

v. That of comparing the different amounts to which an original quantity will be changed by different given per centage rates of increase or diminution.

Of these five cases successively take the following five examples:—

Ex. (1) Calculate $3\frac{1}{8}$ per cent. on 245.

The result is to be $3\frac{1}{8}$ taken as often as 245 contains 100; hence $\frac{245}{100}$ of $3\frac{1}{8} = \frac{49}{20}$ of $\frac{25}{8} = 7\frac{21}{32}$. *Ans.*

Ex. (2) A dealer buys a job lot of goods for £28, and sells them for £31 10*s.*; what does he gain per cent.?

On 28 he gains $3\frac{1}{2}$; ∴ on 100 he gains $\frac{100}{28}$ of $3\frac{1}{2}$ $= 12\frac{1}{2}$ per cent. *Ans.*

Ex. (3) A merchant buys goods for £175; for what will he sell them, if he is to gain 4 per cent.? and for what, if he must lose 4 per cent.?

$\frac{£175}{£100}$ of £104 = £182, 1st *Ans.* $\frac{£175}{£100}$ of £96 = £168, 2nd *Ans.*

Ex. (4) A merchant sells goods for £182, gaining thereby 4 per cent.; what did they cost him?

He obtains £104 for what cost him £100;

∴ he gets £182 for what cost him $\frac{182}{104}$ of £100.

$= \frac{7}{4}$ of £100 = £175. *Ans.*

Ex. (5) If by selling wine at 5*s.* a bottle I gain 5 per cent., at what must I sell it to gain $8\frac{1}{2}$ per cent.?

The selling prices are as 105 to $108\frac{1}{2}$;

$$\therefore \frac{108\frac{1}{2}}{105} \text{ of } 5s. = \frac{31}{30} \text{ of } 5s. = 5s.\ 2d. \quad \textit{Ans.}$$

2. Given, that one quantity m is r per cent. of another quantity n; to find how much per cent. n is of m.

Ex. (6) A's money is equal to $62\frac{1}{2}$ per cent. of B's; how much per cent. is B's money of A's?

A's money is to B's as $62\frac{1}{2}$: 100, or as 1 : $\frac{100}{62\frac{1}{2}}$. or as 100 : $\frac{10000}{62\frac{1}{2}}$, that is, as 100 : 160, which means that B's money is equal to 160 per cent. of A's. *Ans.*

3. Given, that one quantity m is r per cent. *more* than another quantity n; to find how much per cent. n is *less* than m.

Ex. (7) A's money is $12\frac{1}{2}$ per cent. more than B's: how much per cent. is B's less than A's?

A's money is to B's as $112\frac{1}{2}$: 100, or as 1 : $\frac{100}{112\frac{1}{2}}$, or as 100 : $\frac{10000}{112\frac{1}{2}}$, that is, as 100 : $88\frac{8}{9}$; which means that B's money is $11\frac{1}{9}$ per cent. less than A's. *Ans.*

4. Examples like the following are often proposed:—

Ex. (8) A wine merchant, having bought 80 gallons of claret at 6*s.* 4*d.* a gallon, sells 35 gallons of it at 6*s.* 9*d.*; at what must he sell the remainder per gallon, that his gain on the whole may be $12\frac{1}{2}$ per cent.?

80 gall. bought at 6*s.* 4*d.*	=	506*s.* 8*d.*
Proposed gain, $12\frac{1}{2}$ per cent.	=	63 4
		570 0
35 gall. sold at 6*s.* 9*d.*		236 3
45 gall. to be sold for		333*s.* 9*d.*

which is at 7*s.* 5*d.* a gall. *Ans.*

Examples for Practice.

(1) How much per cent. is 5*d.* in the pound? *Ans.* $2\frac{1}{12}$.

(2) How much is a gain of $16\frac{7}{8}$ per cent. on an outlay of £75? *Ans.* £12 13*s.* $1\frac{1}{2}d.$

(3) How much per cent. on £254 13*s.* 9*d.* is £13 11*s.* 8*d.*? *Ans.* $5\frac{1}{3}$.

(4) Calculate $1\frac{1}{4}$ per cent. commission on £526 14*s.* 2*d.* *Ans.* £6 11*s.* $8\frac{1}{8}d.$

(5) A tradesman buys a house for £1140, and sells it again at a profit of $9\frac{1}{3}$ per cent.; what does he get for it? *Ans.* £1246 8*s.*

(6) At what loss per cent. do I sell for $14\frac{1}{2}d.$ an article that cost me 1*s.* 8*d.*? *Ans.* $27\frac{1}{2}$.

(7) I paid 27*s.* a ton for coals last month; they are now $5\frac{5}{9}$ per cent. cheaper. What is the present price? *Ans.* 25*s.* 6*d.*

(8) If a tobacconist sells a 2-ounce packet of tobacco for $10\frac{1}{2}d.$ which costs him $8\frac{3}{4}d.$, what does he gain per cent.? *Ans.* 20.

(9) The nett amount of an invoice, after an allowance of $2\frac{1}{2}$ per cent. discount, is £100 5*s.* 3*d.*; what is the gross amount? *Ans.* £102 16*s.* 8*d.*

(10) Cheese bought at 81*s.* 8*d.* a cwt. is sold at 10*d.* a lb.; what is gained per cent.? *Ans.* $14\frac{2}{7}$.

(11) By selling spirits at 15*s.* 2*d.* a gallon, a merchant gains 17 per cent.; what did the gallon cost him? *Ans.* 12*s.* $11\frac{5}{8}d.$

(12) A sells at 1*s.* 6*d.* a yard an article which B sells at 1*s.* 6¾*d.* How much per cent. is A's price cheaper than B's? and how much per cent. is B's dearer than A's? *Ans.* 4 p. c.; 4⅛ p. c.

(13) The present population of a village is 2136, which is about 11 per cent. less than it was 10 years ago. What was the former population? *Ans.* 2393.

(14) If eggs cost me 10½*d.* a dozen, how many should I give for a shilling to gain 37 per cent.? *Ans.* 10, *very nearly.*

(15) A publican gave 15*s.* a gallon for 55 gallons of rum; and he has sold 45 gallons of it at 17*s.* 5*d.* a gallon. At what price per gallon must he dispose of the remainder, that his gain on the whole may be 15 per cent. *Ans.* 16*s.* 6*d.*

(16) What was the prime cost of a piano-forte, on which a tradesman loses 14½ per cent. by selling it for £38? *Ans.* £44⅘.

(17) If a grocer by selling tea at 2*s.* 8*d.* a lb. gains 6⅔ per cent., by what selling price would his gain be 10 per cent.? *Ans.* 2*s.* 9*d.*

(18) A merchant bought a piece of silk 56 yards long for £10; and he has sold ⅜ of it for 6 guineas. At how much per yard must he sell the remainder, that his gain on the whole may be 12 per cent.? *Ans.* 4*s.* 4½*d.*

(19) Silk bought at £12 per piece of 52 yards is sold at 4*s.* 10*d.* a yard; what is the gain per cent.? *Ans.* 4$\frac{3}{11}$.

(20) A merchant in France, having bought 16 puncheons of brandy at 207 francs per puncheon, has sold 11 puncheons of it at 231 francs; at what price must he sell the remainder to gain 12½ per cent. on the whole? *Ans.* 237 fr.

(21) A salesman will lose 5⅛ per cent. if he sell bacon at 77*s.* a cwt.; what will he gain or lose per cent. if he sell it at 80*s.*? *Ans.* Lose 1⅜ p. c.

(22) If by selling cotton at the rate of 484 francs for 7 bales a trader would gain 4½ per cent., what would be his gain per cent. by selling it at the rate of 616 francs for 9 bales? *Ans.* 3⅓ p. c.

(23) A shipowner gained 16 per cent. by selling a vessel for £2030, but would have gained 20 per cent. had he got what he expected for it. How much did he expect? *Ans.* £2100.

(24) I shall lose 8 per cent. if I sell at 5*s.* 9*d.*; what shall I gain or lose per cent. if I sell at 6*s.* 6*d.*? *Ans.* Gain 4 p. c.

(25) If a person's income was 40 per cent. less last year than it is this, how much more per cent. is it this year than it was last? *Ans.* 66⅔.

(26) The selling price of an article is 107½ per cent. of the prime cost; how much per cent. of the selling price is the prime cost?

(27) Suppose that two equally large and commodious houses are let—one at £62 10*s.* a quarter in advance, the other at £63 15*s.* 9*d.* a quarter in arrear:—which is the higher rent, and by how much per cent., if interest is reckoned at 5 per cent. per annum? *Ans.* Latter, by ⅛ p. c.

(28) By selling wheat at a certain price per quarter, I lost 4 per cent.; but had I obtained 4*s.* 6*d.* a quarter more for it, I should have gained 4 per cent. At what price did I sell it? *Ans.* 54*s.*

(29) Suppose the price of an article to be 7·27 per cent. cheaper now than it was formerly; how much per cent. dearer was it formerly than it is now? *Ans.* 7·84.

(30) A stock of iron is increased 2½ per cent. by further purchase; and the quantity then on hand is diminished 2½ per cent. by sales. The stock now amounts to 529 tons 13 cwt. 42 lb. Find the original quantity. *Ans.* 530 tons.

(31) If 35 copies of a book can be got for £9 16*s.* 10½*d.* when there is an allowance of 25 per cent. discount on the publishing price, find, without taking the publishing price into the calculation, how many copies can be got for £11 16*s.* 3*d.* if 30 per cent. discount were allowed? *Ans.* 45.

(32) Having bought a certain quantity of cloth, I sold 28 yards of it, at a profit of 3½ per cent., for £18 2*s.* 3*d.*; but I was obliged to sell the remainder at a loss of 2½ per cent. for £24 7*s.* 6*d.* Find, without taking the prime cost into the calculation, how many yards there were in all. *Ans.* 68.

CHAPTER V.

AVERAGING OF TWO RATES.

1. An example of the following kind often occurs; it presents no difficulty.

Ex. (1) A blend is formed of two kinds of whisky respectively worth 19*s.* 6*d.* and 16*s.* 4*d.* a gallon; 7 gallons of the former are mixed with 12 gallons of the latter. Find the worth of the mixture per gallon.

Here, 7 gallons at 19*s.* 6*d.* = 136*s.* 6*d.*
and 12 „ at 16*s.* 4*d.* = 196*s.* 0*d.*

The 19 gall. amount to . . 332*s.* 6*d.*
and are therefore worth 17*s.* 6*d.* a gall. *Ans.*

But when the two prices are given, and it is required to find what quantities at these prices will, when mixed, form a compound worth a proposed average price, the question is not so simple. Let an example of this kind be derived from the preceding.

Ex. (2) In what proportions must we mingle whiskies at 19*s.* 6*d.* and 16*s.* 4*d.* a gallon, to form a compound worth 17*s.* 6*d.*?

Observe that the price per gallon of the *superior* whisky is to be *lowered* by 2*s.*, and *to make up for this*, the price per gallon of the *inferior* whisky is to be *raised* by 1*s.* 2*d.*; hence, if there be *x* gallons of the

former, and y of the latter, x times 2*s.* must balance, or equal, y times 1*s.* 2*d.*, and therefore $x = \frac{1s.\ 2d.}{2s.}$ of y, or the quantity at the first price is to be $\frac{7}{12}$ of the quantity at the second. *Ans.*

The working, therefore, of this 2nd example may be done briefly by writing the average price on the right of the two other prices, and then obtaining from them, and *transposing* the differences, 24 and 14, as follows:—

$$\left.\begin{array}{l} 14 \text{ at } 234d. \\ 24 \text{ at } 126d. \end{array}\right\} 210d.$$

2. The following variety deserves notice:—

Ex. (3) A mixture of 130 gallons of whisky is made up of two sorts, one worth 15*s.* a gallon, and the other, 25*s.*; and the value of the whole is £136 10*s.* Find the quantities.

Here the average price per gallon = 2730*s.* ÷ 130 = 21*s.*; hence the following arrangement and results:—

$$\left.\begin{array}{l} 4 \text{ at } 15s. \\ 6 \text{ at } 25s. \end{array}\right\} 21s.$$

Hence the two portions of the 130 gallons are as 4 : 6 or 2 : 3; and we have

$$\left.\begin{array}{l} \frac{2}{5} \text{ of } 130 \text{ gall.} = 52 \text{ gall. at } 15s. \\ \frac{3}{5} \text{ of ditto} = 78 \text{ „ at } 25s. \end{array}\right\} \textit{Ans.}$$

3. In Excise business spirits are compared according to degrees of strength; the standard of comparison being 100 gallons of spirits containing 50 gallons alcohol, and thus constituting what is called Proof

spirit. If, therefore, a spirit is of such strength that 100 gallons of it are equivalent to 120 of Proof spirit, it is said to be 20 per cent. *over proof* (o. p.); but if 100 gallons of it are equivalent to 93 of Proof spirit, it is said to be 7 *under proof* (u. p.):—in the former case each gallon is worth 120 ÷ 100, or 1·2 of a proof gallon, and in the latter each gallon is worth 93 ÷ 100, or ·93 of a proof gallon.

Note.—The strength of water is 100 u. p. = 0.

Ex. (4) If $7\frac{1}{2}$ gallons of water be added to a blend of 54 gallons spirits 17 per cent. o. p. and 81 gallons of 12 o. p., find the strength of the mixture.

Strength per 100 gall. of the given blend

$$=(54\times117+81\times112)\div135=114.$$

Now, the quantities $7\frac{1}{2}$ and 135 are as 1 : 18;

1 of water at	0 =	0
to 18 of spirits at	114 =	2052
19		)2052
		108 = 8 o. p. *Ans.*

Ex. (5) In what proportions must spirits 13 o. p. and spirits 6 u. p. be mingled, to form a compound of the strength 9 o. p.?

Here the rates of strength per 100 gallons are 113, 94, and 109; and we are to find the proportions at 113 and 94 to form an average at 109; hence the following arrangement and results:—

$$\left.\begin{matrix}5 \text{ at } 113\\4 \text{ at } 94\end{matrix}\right\} 109;$$

which shows that the proportions must be 5 gall. of the stronger to 4 of the weaker. *Ans.*

Ex. (6) To a blend of 250 gallons at 14 o. p. and 340 at 12 u. p. spirits at 25 o. p. are added, to bring the strength up to 11 o. p. What is the quantity added?

The average rate of strength per 100 gallons of the given blend $=(250\times114+340\times88)\div590=99$ nearly; and we are now to find the quantity at 125 to be mixed with 590 gallons at 99, to obtain the strength 111:—hence,

$$\left.\begin{matrix}14 \text{ at } 99\\12 \text{ at } 125\end{matrix}\right\}111;$$

the proportion is $\frac{12}{14}$ or $\frac{6}{7}$ of $590 = 505{\cdot}7$ gall. *Ans.*

Examples for Practice.

(1) Find the two least whole numbers such that 8 times one together with 18 times the other shall be equal to 11 times their sum. *Ans.* 7 and 3.

(2) In what quantities must teas at 3*s.* 4*d.* and 2*s.* 9*d.* per lb. be mixed, to make the mixture worth 3*s.* per lb.? *Ans.* As 3 : 4.

(3) Two single-volume editions of a book are sold, one at 2*s.* 1*d.*, the other at 6*d.* How many copies of the cheaper edition along with 3 dozen copies of the dearer would make the books cost on an average 18*d.* a volume? *Ans.* 15.

(4) In what proportions must gold of 13 carats fine be combined with gold of 22 carats fine, that the compound may be 18 carats fine? *Ans.* 4 oz. to 5 oz.

(5) How much brandy at 18*s.* a gallon, if mixed with a dozen gallons at 22*s.* 6*d.*, will make a compound worth 22*s.* a gallon? *Ans.* $1\frac{1}{2}$ gall.

(6) A mixture is made of two sorts of tobacco, at 5*s.* 3*d.* and 6*s.* 5*d.* a lb. respectively, and is worth 6*s.* a lb. How much of each sort is there in a cwt. of the mixture? *Ans.* 40 lb.; 72 lb.

(7) How much tea at 3*s.* 3*d.* a lb. does a tea merchant mix with 3 lb. at 4*s.* 2*d.*, if he gain $6\frac{2}{3}$ per cent. by selling the mixture at 4*s.*? *Ans.* $2\frac{1}{2}$ lb.

(8) Divide 33*s.* into two parts, so that 13 times one added to 19 times the other shall amount to £26 17*s.* *Ans.* 15*s.*; 18*s.*

(9) What quantity of water is required to reduce 155 gallons of spirit 15 per cent. o. p. to 3·6 per cent. u. p.? *Ans.* 29·1 gall.

(10) How much spirit 13 per cent. o. p. must be added to a blend of 20 gallons 19·4 per cent. o. p. and 32 gallons 17·3 o. p. to produce a mixture 16 per cent. o. p.? *Ans.* 36·4 gall.

(11) I have mixed 26 gallons spirits 11 o. p. with 16 gallons $4\frac{1}{2}$ u. p.; if I add $3\frac{1}{4}$ gallons water to the mixture, what will be the strength of the diluted spirit? *Ans.* 2·453 u. p.

(12) How many gallons spirits at 18 o. p., and how many at 14 o. p., will, if mixed together, form a compound of 96 gallons equivalent to 111 proof gallons? *Ans.* 39 and 57 gall.

CHAPTER VI.

Scales of Notation.

1. In the ordinary expression of numbers by means of the figures 0 to 9, we use what is called decimal or denary notation, making the scale of local values, from right to left, successively denote units, tens, squares of ten, cubes of ten, fourth powers of ten, &c. Thus the ordinary decimal or denary number 42980 is made up of—

0 units	written	0
8 tens of units	„	80
9 hundreds of units ..	„	900
2 thousands of units ..	„	2000
4 ten-thousands of units	„	40000
		42980

2. If we used a scale with a radix of *twelve*, instead of *ten*,—a duodecimal or duodenary scale of notation,—we should necessarily have two numerical characters more than there are in the denary system, say *t* for *ten*, and *e* for *eleven*, to stand in units place, so that 10 should denote *twelve*, 100 the *square of twelve*, 1000 the *cube of twelve*, and so on; that is, making the local values of figures, from right to left, successively denote so many *units, twelves, squares of twelve, cubes of twelve*, &c.

Now, the ordinary number 42980 has its value expressed by 20*t*58 duodenary; for—

8 units	=	·8	denary.
5 twelves	=	60	„
t squares of twelve	=	1440	„
2 fourth powers of twelve	=	41472	„
		42980	denary.

3. The most convenient mode of transforming 42980, denary, into its equivalent duodenary, and that of transforming 20*t*58, duodenary, into its equivalent denary, are as follows:—

12)42980 *den.*
12)3581 twelves + 8 units,
12)298 squares of twelve + 5 twelves,
12)24 cubes of twelve + *t* squares,
2 fourth-powers of twelve + 0 cubes;

thus giving 20*t*58 duodenary; and this again is retraced to the denary form, by multiplying from the left by twelve successively, and adding successively the figures on the right, as in the annexed form of operation, which may now be compared with the less convenient form already given.

12	
24	
12	
298	
12	
3581	
12	
42980	

4. A scale according to which the local values towards the left are successively twice as great as the preceding one on the right is called the binary scale; and so on with the ternary, quaternary, quinary, senary, septenary, octonary, nonary, denary

or decimal, undenary, duodenary or duodecimal, ternidenary, or scale of 13, &c.

We shall now present some additional examples of scale transformation.

Ex. (1) Express the common numbers 253 and 1406 in the septenary scale.

7)253
7)36 sevens + 2 units,
5 squares of seven + 1 seven.
Hence 512 *sept.* *Ans.*

7)1406
7)200 sevens + 6 units,
7)28 squares of seven + 4 sevens,
4 cubes, 0 squares. Hence 4046 *sept.* *Ans.*

Ex. (2) Convert 57*e*8*t* from the duodenary to the octonary scale.

This may be done in either of two ways. We may first convert the given number to the denary form by multiplication, and then the result to the octonary by division; as follows:—

57*e*8*t* *duoden.*
12
67
12
815
12
9788
12
117466 *denary.*

8)117466 *den.*
8)14683 ... 2
8)1835 ... 3
8)229 ... 3
8)28 ... 5
3 ... 4

Ans. 345332 *octon.*

But the conversion is best performed at once by division; thus, 5 times twelve are 60, and 7 make 67; so 8 in 67 goes 8 times with 3 over; then 3 times twelve are 36, and *e* make 47; so 8 in 47 goes 5 times with 7 over; 7 times twelve are 84, and 8 make 92; so 8 in 92 goes *e* times, &c.

8)57*e*8*t*	*duoden.*	
8)85*e*7	...	2
8)108*e*	...	3
8)171	...	3
8)24	...	5
3	...	4

NOTE.—As in simple addition, subtraction, &c. of ordinary numbers we carry *one* for *ten*, the basis or radix of the decimal scale, so in a *binary* scale we should have to carry one for *two*, written 10 in that scale; also in the *ternary*, in which *three* is expressed by 10, we would carry one for *three*, in the *quaternary*, in which *four* is written 10, we would carry one for *four*; and so on. As in the *decimal* system we have no numerical character of higher value than 9, so in the *quinary* we have none higher than 4, in the *nonary* none higher than 8; for the *undenary* and the *duodenary*, as for all scales higher than the common decimal notation, the arabic numerals do not supply enough of symbols; it is customary, however, to use *t* and *e* as characters for *ten* and *eleven*.

What further it may be expedient that the arithmetical pupil should be acquainted with respecting integer values and rules in Scales of Notation, will be best learned from a few more worked examples. The comparison of decimal and other radix fractions is a subject introduced in Section 5.

Ex. (3) Add the senary numbers 53501 and 5324,

convert the result into septenary form, and from the latter result subtract 26046 septenary.

53501 *sen.*	7)103225 *sen.*	33551 *septen.*
5324	7)5344 . . 1	26046
103225	7)445 . . 5	4502. *Ans.*
	7)40 . . 5	
	3 . . 3	

Observe that, in the above senary addition, the procedure is as follows: 4 and 1 are 5, 2 and 0 is 2, 3 and 5 make eight, which being written 12 in the senary scale, we set down 2 and carry 1, then 1 and 5 are *six* and 3 make *nine*, which being written 13 by the senary notation, we set down 3, and carry 1 to 5 making *six*, that is, 10. So with the septenary subtraction on the right, the operation is as follows: 6 from 1 cannot be taken, borrow *seven*, or 10, then 6 from *eight* leaves 2; now carry 1 to 4 makes 5, leaving 0; 0 from 5 leaves 5; 6 from *ten* leaves 4.

Ex. (4) Multiply together the undenary numbers 58*t*3 and *t*97.

The multiplication here is worked as follows: 7 times 3 are *twenty-one* (in undenary form 1 *t*) set down *t* and carry 1; 7 times *t* are *seventy*, and 1 makes *seventy-one*; *eleven* in *seventy-one* goes 6 times with 5 over; and so on.

58*t*3	*und.*
*t*97	
3775*t*	
48345	
53138	
58238 *t t*	*und.*

Ex. (5) Find the quotient of 3320086 by 374, the radix being 9.

374)3320086(7806 *nonary. Ans.*
2871
3380
3355
2486
2486

In division like the above, it is rather troublesome to guess at the quotient figures; but there is rarely any demand for quick work in this curious kind of arithmetic, and the student must be content to try, till he finds out the proper number of times.

Ex. (6) Reduce the quinary fraction $\frac{3433}{22122}$ to its lowest terms, working throughout in quinary notation.

Here we have first to find the G. C. M. of the two terms, and then to cancel it from each.

3433)22122(3
21404
213)3433(13
213
1303
1144
G. C. M. 104)213(2
213

104)3433(32
322
213
213
104)22122(203
213
322
322

Ans. $\frac{32}{203}$ *quinary.*

5. A decimal fraction is a radix fraction in the denary scale, and has the understood denominator

10 for a decimal of one place, 10^2 or 100 for a decimal of two places, &c. So a radix fraction in the senary scale has the understood denominator 10 senary (= 6 denary) for a radix fraction of one place, 10^2 senary = 100 senary (= 6^2 denary) for one of two places, and so forth.

Accordingly, $325\frac{43}{100}$ senary may be written 325·43; and we will now show how this expression may be transformed to equivalents of other scales.

Ex. (7) Reduce 325·43 senary to denary notation.

First, 325 senary reduced to denary is 125;

$$\begin{array}{r} 6 \\ \hline 20 \\ 6 \\ \hline 125 \end{array}$$ denary;

then, ·43 senary is to be reduced to tenths and hundredths of unity, by multiplying successively by *ten*, as follows:—

0·43 senary

$$\begin{array}{r} 10 \\ \hline 7\cdot30 \end{array}$$ = 7 tenths of unity + 3 sixths of a tenth;

$$\begin{array}{r} 10 \\ \hline 5\cdot00 \end{array}$$ = 5 hundredths of unity;

in all, 7 tenths, 5 hundredths, or 75 hundredths; and thus we have 325·43 senary = 125·75 denary. *Ans.*

Ex. (8) Reduce 325·43 senary to octonary notation.

An octonary integer consists of units, eights, sixty-fours, &c., from right to left; an octonary radix fraction consists of eighths, sixty-fourths, five-

hundred-and-twelfths, &c., from left to right. Hence the given senary may be reduced as follows:—

8)325 senary,	0·43 senary
8)23 + 5 units,	8
8)1 + 7 eights,	6·00 eighths of unity;
0 + 1 sixty-four;	

thus we have 325·43 senary = 175·6 octonary. *Ans.*

Ex. (9) Reduce 325·43 senary to septenary notation.

7)325 senary;	0·43 senary;
7)25 + 6 units,	7
7)2 + 3 sevens,	5·13
0 + 2 forty-nines;	7
	1·43

Here it is seen that the septenary radix fraction will be a circulate, which may be written $\cdot\dot{5}\dot{1}$, and is equal to $\frac{51}{66}$ septenary. Thus we have 325·43 senary = 236·$\dot{5}\dot{1}$ septenary. *Ans.*

6. In general, for radix fractions of one scale, we obtain only approximate values in other scales.

Ex. (10) Convert ·4654 septenary to nonary notation. Here we shall have to multiply by 9 successively to obtain 9ths, 81ths, 729ths, &c. We need not write the multiplier more than once.

·4654 septenary;

9

6·2511 = 6 (9ths)	of unity	+ ·2511	sept. of	$\frac{1}{9}$ den.
3·3432 = 3 (81ths)	,,	+ ·3432	,,	$\frac{1}{81}$,,
4·4514 = 4 (729ths)	,,	+ ·4514	,,	$\frac{1}{729}$,,
6·0501 = 6 (6561ths)	,,	+ ·0501	,,	$\frac{1}{6561}$,,

Hence ·4654 septenary = ·6346 + nonary. *Ans.*

7. The method of converting a denary or ordinary number into the corresponding expression for a different base may be applied to such questions as the following:—

Ex. (11) Having given weights of 1 ($= 3^0$),* 3 ($= 3^1$), 3^2, 3^3, 3^4, &c. lb., how might 142 lb. be weighed by means of them?

We are here required to express 142 in powers of 3.

Now, 142 denary is equal to 12021 tenary; and we thus have 142 lb. = (1 of 3^4 + 2 of 3^3 + 2 of 3^1, + 1 of 3^0) lb.; hence it appears that we must put into one scale 1 weight of 81 lb. + 2 of 27 lb. each + 2 of 3 lb. each + a 1 lb. weight, in order to balance 142 lb. in the other scale.

But if there be not more than one weight of each kind, we have to express 142 in *single* powers of 3, and must therefore divide 142 successively by 3 in such a way as to avoid remainders of 2, by substituting remainders of -1; and the negative remainders will represent make-up weights for the scale containing the substance to be weighed. Thus:—

3)142	hence we must select single
3)47 + 1 of 3^0	weights of 3^5, 3^2, and 1, lb. for
3)16 − 1 of 3^1	one scale, and single weights of
3)5 + 1 of 3^2	3^4, 3^3, and 3, lb. to be put with
3)2 − 1 of 3^3	the 142 lb. weight in the other
3)1 − 1 of 3^4	scale.
0 + 1 of 3^5	

* Any abstract quantity having *zero* for an index denotes 1; thus $8^0 = 1$, $15^0 = 1$, $x^0 = 1$.

Examples for Practice.

(1) Express by the nonary scale the value of the common number 746, and by the common scale the value of the octonary 3505. *Ans.* 1018; 1861.

(2) Reduce 5303 in the septenary scale to the decimal and senary scales. *Ans.* 1865; 12345.

(3) What common number has its value expressed by the quaternary number 11231? And how is *t*8*t*46 in the undenary scale expressed in the ternidenary, or scale of 13? *Ans.* 365; 570*t*4.

(4) Reduce the octonary number 105775757, and the undenary number 1420911, to the duodecimal scale; and find the sum and the difference of the results. *Ans.* Sum, 6*e*6*t*303; diff. 53*te*08*e*.

(5) Find, by septenary calculation, the square root of the septenary number 420652. *Ans.* $533\frac{1}{3}$.

(6) Find in lowest terms the difference of $\frac{62}{104}$ and $\frac{23}{75}$, nonary scale, working throughout by nonary calculation. *Ans.* $\frac{7}{20}$.

(7) Compute directly by the senary scale the lowest senary terms expressing the ratio of 2510 septenary to 13001 quinary. *Ans.* 342 : 355.

(8) Reduce the octonary fractions $\frac{20}{25}$ and $\frac{11}{34}$ to a common denominator, and then find their sum in simplest octonary terms. *Ans.* $\frac{15}{14}$.

(9) Find the greatest octonary common measure of the octonary numbers 25366 and 231311.
Ans. 215.

(10) What is the least nonary common multiple of the nonary numbers 245, 351, 426, 436?
Ans. 1282636, nonary.

(11) Change to the denary scale and then simplify the following senary expression:—

$$\frac{223\frac{11}{12}}{115\frac{1}{2}} - \frac{211\frac{21}{30}}{144\frac{15}{120}}. \qquad \textit{Ans.} \quad \frac{709}{1140}$$

(12) Divide according to the duodenary scale $e3664\frac{1}{2}$ by 249, and convert the result to the denary scale. *Ans.* $486\frac{9}{t}$ duoden. $= 678\frac{9}{176}$ denary.

(13) Reduce $\frac{11}{21}\frac{5}{3}$ senary scale to a senary radix fraction. *Ans.* ·3252 sen.

(14) Reduce ·580247 denary to ternary notation.
Ans. ·1202 + tern.

(15) Reduce 39·05375 denary to quinary.
Ans. 124·01133 −.

(16) Reduce 326·4793 denary to nonary.
Ans. 402·42736 +.

(17) Reduce ·214 senary to a decimal fraction.
Ans. ·3796 +.

(18) Convert ·00246 septenary to denary.
Ans. ·007854 −.

(19) Convert 907·012061 undenary to denary.
Ans. 1096·009805.

(20) Convert 3·02101 quaternary to denary.
Ans. 3·1416.

(21) Transform ·34312 octonary to an undenary radix fraction. *Ans.* ·49757 +.

(22) Transform ·0034545 septenary to a quinary radix fraction. *Ans.* ·00113244 +.

(23) Express by a quaternary radix fraction the value of ·344411 septenary. *Ans.* ·2012 +.

(24) Transform ·08456 undenary to a radix fraction in the scale of *six*. *Ans.* ·02300233 −.

(25) What duodenary radix fraction is equivalent to ·130654 octonary? *Ans.* ·20e9t3 +.

(26) Find in ternary notation the square root of the sum of $\frac{30}{103}$ quinary + $\frac{35}{100}$ senary + $\frac{53}{120}$ septenary. *Ans.* $1\frac{1}{10}$, or 1·1.

(27) If the only coins in circulation were respectively worth 1, 2, 4, 8, 16, and 32 shillings, how could a debt of 29 shillings be paid without using more than one of the same sort of coin?
Ans. $2^4 + 2^3 + 2^2 + 2^0$ shillings.

(28) Which of a series of vessels, capable of containing 1, 2, 4, 8, 16, &c., gallons of water, can be all exactly filled from a cistern containing 174 gallons? *Ans.* The 2nd, 3rd, 4th, 6th, and 8th.

(29) Find which of the weights 1, 3, 3^2, 3^3, 3^4, 3^5 lb. must be selected, and how they must be used, in order to weigh 204 lb. *Ans.* In one scale 3^5, in the other the given substance along with 3^3, 3^2, and 3^1.

(30) A parcel of goods weighing 53 lb. can be weighed by means of four weights of 1, 4, 16, and 64 lb. respectively. How are the weights to be used? *Ans.* $4^3 + 4^1 + 4^0 - 4^2$ lb.

(31) How could 11 lb. of tobacco be weighed by means of weights of 1, 3, 9, 27, 81, and 243 ounces, if two weights of each kind are available? and how, if there were only one weight of each kind? *Ans.* (i) 2 of $3^4 + 1$ of $3^2 + 1$ of $3^1 + 2$ of 3^0; *Ans.* (ii) $3^5 + 3^3 - 3^4 - 3^2 - 3^1 - 3^0$.

(32) A owes B for goods, value 15*s.* 4*d.* Suppose the only coins in circulation to be respectively worth 20*s.* 3*d.*, 6*s.* 9*d.*, 2*s.* 3*d.*, 9*d.*, 3*d.*, and 1*d.*; how could the discharge of the debt be managed between A and B, when each person has not more than one piece of each kind? *Ans.* By A giving B the coins 20*s.* 3*d.*, 2*s.* 3*d.*, 9*d.* and 1*d.*, and receiving from B the coins 6*s.* 9*d.* and 3*d.*

APPENDIX.

Specimen of an Arithmetic Paper, together with the Answers worked out, as a Study in Method and Style for Candidates.

Questions.

1. Add together $6\frac{9}{14}$, $6\frac{3}{8}$, $\frac{7}{12}$, $\frac{4}{21}$.

2. From $80\frac{5}{24}$ subtract $19\frac{8}{15}$.

3. Multiply together $7\frac{3}{7}$, $23\frac{5}{8}$, and $\frac{25}{39}$.

4. Divide $3\frac{303}{406}$ by $\frac{116}{551}$.

5. Divide 53·46 by ·216.

6. Divide $4\cdot64\dot{8}$ by $\cdot43\dot{7}0\dot{3}$.

7. Express the value of 53*s.* $9\frac{3}{4}$*d.* in guineas and the decimal of a guinea.

8. What decimal of £2 13*s.* $11\frac{1}{2}$*d.* is 5*s.* 10*d.*?

9. Reduce ·145215 of a square mile to acres, roods, perches.

10. If 24 men can finish a piece of work in 26 days, in what time could 27 men finish it?

11. What quantity of cheese is worth 18*s.* $11\frac{13}{16}$*d.*, at the rate of 16*s.* 3*d.* for $20\frac{3}{8}$ lb.?

12. Find the simple interest on £134 17*s.* 6*d.* for 3 years, at $3\frac{1}{4}$ per cent. per annum.

13. What sum will in 9 months amount to £86 18*s.* 8*d.* by simple interest, at $2\frac{1}{2}$ per cent. per annum?

14. What would £267 13*s.* $5\frac{1}{2}$*d.* amount to by compound interest in 3 years, at $4\frac{1}{3}$ per cent. per annum?

15. A by himself could finish a piece of work in 14 hours, which B alone could do in $17\frac{1}{2}$ hours, and C alone in 20 hours. In what time would the three together finish the work?

ANSWERS.

(1) $6\frac{9}{14} + 6\frac{3}{8} + \frac{7}{12} + \frac{4}{21} = 12 + \frac{108+63+98+32}{168}$
$= 12 + \frac{301}{168} = 12 + \frac{43}{24} = 13\frac{19}{24}$. *Ans.*

(2) $80\frac{5}{24} - 19\frac{8}{15} = 61 + \frac{25-64}{120} = 61 - \frac{39}{120} = 61 - \frac{13}{40}$
$= 60\frac{27}{40}$. *Ans.*

(3) $\frac{52}{7} \times \frac{189}{8} \times \frac{25}{39} = \frac{4 \times 13 \times 7 \times 27 \times 25}{7 \times 8 \times 13 \times 3} = \frac{9 \times 25}{2}$
$= 112\frac{1}{2}$. *Ans.*

(4) $\frac{1521}{406} \times \frac{561}{418} = \frac{9 \times 13 \times 13 \times 29 \times 19}{14 \times 29 \times 13 \times 32} = \frac{9 \times 13 \times 19}{14 \times 32}$
$= \frac{2223}{448} = 4\frac{431}{448}$. *Ans.*

(5)
$$216)53460\cdot0(247\cdot5 \quad \textit{Ans.}$$
$$\underline{1026}$$
$$1620$$
$$\underline{1080}$$

(6) $\frac{1}{10}$ of $46\frac{48}{99} \div \frac{1}{100}$ of $43\frac{703}{999} = \frac{461\frac{6}{33} \times 10}{43\frac{19}{27}}$
$= \frac{1534 \times 10 \times 27}{1180 \times 33} = \frac{767 \times 9}{59 \times 11} = \frac{13 \times 9}{11} = 10\frac{7}{11}$,
or $10\cdot\dot{6}\dot{3}$. *Ans.*

(7)
$$\begin{array}{r|l} 12 & 9\cdot75d. \\ 21\{\ 3 & 53\cdot8125s. \\ 7 & 17\cdot9375 \end{array}$$
$2\cdot5625$ guin. *Ans.*

(8) $\frac{5s.\ 10d.}{53s.\ 11\frac{1}{2}d.} = \frac{70}{647{\cdot}5} = \frac{100}{925} = \frac{4}{37} = {\cdot}\dot{1}0\dot{8}$. *Ans.*

(9) $\frac{1 \text{ square mile}}{1 \text{ acre}} = \frac{1760 \text{ sq. yds.} \times 1760}{4840 \text{ sq. yds.}}$

$= \frac{1760 \times 4}{11} = 640$;

·145215 of 640 ac.
80
11·6172
8
92·9376 ac.
4
3·7504 ro.
40
92 ac. 3 ro. 30·016 p. *Ans.*

(10) 1 man would take 24 times 26 days;
∴ 27 men would take $\frac{24}{27}$, or $\frac{8}{9}$, of 26 da.
$= 23\frac{1}{9}$ da. *Ans.*

(11) $\frac{227\frac{13}{16}d.}{195d.}$ of $\frac{182 \text{ lb.}}{9} = \frac{3645}{195 \times 16}$ of $\frac{182 \text{ lb.}}{9}$

$= 14 \text{ lb.} \times \frac{405}{15 \times 16} = 7 \text{ lb.} \times \frac{27}{8} = 23\frac{5}{8} \text{ lb.}$ *Ans.*

(12) Total interest on £100 $= £3\frac{1}{4} \times 3 = £9\frac{3}{4}$;
∴ ditto on £134 17*s.* 6*d.* $= \frac{£134\ 17s.\ 6d.}{£100}$ of $£9\frac{3}{4}$.

$9\frac{9}{12}$
12)1213 17 6
101 3 1½
100)1315 0 7½
Ans. £13 3*s.* $0\frac{3}{40}d.$

£13,15 0*s.* 7½*d.*,
20
3,00
12
,07½
100
$= \frac{3}{40}d.$

(13) 9 months' interest on 100 = $\frac{3}{4}$ of $2\frac{1}{2} = 1\frac{7}{8}$; thus, £101 17*s.* 6*d.* is the amount of £100, and, therefore, £86 18*s.* 8*d.* is the amount of

$$\frac{\text{£86 18}s.\ 8d.}{\text{£101 17}s.\ 6d.} \text{ of £100.}$$

Now, multiplying the terms of this fraction by 6, we have

$$\frac{\text{£521}\frac{3}{8}}{\text{£611}\frac{1}{4}} = \frac{2608 \times 4}{2445 \times 5} = \frac{163 \times 64}{163 \times 75} = \frac{64}{75};$$

hence, $\frac{64}{75}$ of £100 = $\frac{64}{3}$ of £4 = £85 6*s.* 8*d.* *Ans.*

(14)

12	5·5*d.*
20	13·4583333*s.*
	£267·672917

$3\frac{1}{3}$ p. c. = $\frac{1}{30}$ =	8·922430
1 p. c. = $\frac{1}{100}$ =	2·676729
	279·272076 amt. for 1 year.
$\frac{1}{30}$ =	9·309069
$\frac{1}{100}$ =	2·792721
	291·373866 amt. for 2 years.
$\frac{1}{30}$ =	9·712462
$\frac{1}{100}$ =	2·913739
Ans. £304.	304·000067 amt. for 3 years.

(15) L. C. M. of 14, $17\frac{1}{2}$, and 20 = 140; this makes it convenient to suppose the whole work to consist of 140 equal parts; for thus we have A's work per hour = 10 parts, B's 8, C's 7; sum, 25 parts per hour by the three together; therefore they would do the whole 140 parts in $\frac{140}{25}$ of 1 hour = $5\frac{3}{5}$ hours. *Ans.*

EXAMINATION PAPERS IN ARITHMETIC.

PART FIRST.

Vulgar and Decimal Fractions, &c.

No. 1.

1. Add together $2\frac{7}{8}$, $\frac{9}{14}$, $6\frac{4}{7}$, and $\frac{7}{24}$.

2. Subtract $15\frac{25}{27}$ from $20\frac{25}{63}$.

3. Multiply together $\frac{35}{48}$, $1\frac{13}{14}$, and $7\frac{1}{5}$.

4. Divide $4\frac{3}{28}$ by $6\frac{17}{24}$.

5. Add together ·000595, 23·69, 7·0435, and 54·001605.

6. Subtract 78·690493 from 204·6102.

7. Multiply 178·049 by ·30024.

8. Divide ·5883837 by 247·48.

9. Reduce ·7495 of 9 oz. 14 dwt. to grains and the decimal of a grain.

10. What is the value of 6 acres 3 roods 21 perches, if the worth of a rood be £126 13*s.* 4*d.*?

11. Reduce 49540356 square inches to acres, roods, &c.

12. Find the simple interest on £3650 for $3\frac{1}{4}$ years at $4\frac{1}{2}$ per cent. per annum.

13. Add together $\frac{3}{13}$, $3\frac{17}{16}$, $2\frac{7}{176}$, and $7\frac{5}{12}$.

14. Subtract $5\frac{13}{16}$ from $6\frac{11}{12}$.

15. Multiply together $\frac{5}{7}$, $1\frac{7}{5}$, $4\frac{1}{12}$, and $1\frac{13}{14}$.

16. Divide $7\frac{8}{51}$ by $3\frac{15}{68}$.

17. Add together 1·068 of 3 lb. 11 oz. troy and 2·357 of 15 dwt. and give the answer in grains and the decimal of a grain.

18. Subtract 2·4007 quarts from ·9895 of a gallon, and give the answer in pints and the decimal of a pint.

19. Find the product of ·0008479 and 49·6538.

20. Divide 19·52 by ·07625.

21. Divide $754\cdot\dot{5}\dot{4}$ by $\cdot4\dot{5}\dot{7}$.

22. If $6\frac{1}{2}$ ounces of silver be worth £1 14*s.* 6*d.*, what quantity is worth £2 15*s.* 7*d.*?

23. A person contracts to do a piece of work in 30 days, and employs 15 men upon it. At the end of 12 days one-third only of the work is finished. How many additional hands must then be engaged, in order to perform the contract?

24. In what time will £1045 amount to £1136 8*s.* 9*d.* by simple interest, at $3\frac{1}{2}$ per cent. per annum?

25. What sum will amount to £1208 19*s.* $4\frac{1}{4}d.$ in $4\frac{1}{2}$ years, at $2\frac{3}{4}$ per cent. per annum, simple interest?

26. On a map a line 2·15 inches long represents 19·8 furlongs; what length on it represents a mile?

No. 2.

1. Find the sum of $14\frac{7}{9} + 8\frac{5}{12} + \frac{23}{42} + 2\frac{20}{21}$.

2. From $51\frac{1}{52}$ subtract $40\frac{4}{39}$.

3. Find the product of $7\frac{14}{15} \times 9\frac{16}{21} \times 8\frac{13}{15}$.

4. Divide $33\frac{3}{23}$ by $24\frac{1}{46}$.

5. Add together ·039, ·9876, 9·876 and 27·7504.

6. From 4·0094 subtract ·949503.

7. Multiply 1·0086 by 85·47.

8. Divide 4·165 by ·0476.

9. Reduce 1·7056 of 3 acres 2 roods 15 poles 16 yards to square yards and the decimal of a square yard.

10. Find the worth of 53 cwt. 3 qrs. 25 lb. of coals, at the rate of 6*s*. 5*d*. for 7 cwt. 1 qr. 13 lb.

11. Reduce 158933016 square inches to acres, roods, &c.

12. Find the amount, by simple interest, of £221 13*s*. 4*d*. for $4\frac{1}{4}$ years, at $2\frac{1}{2}$ per cent. per annum.

13. Add together $1\frac{4}{21}$, $\frac{7}{15}$, $3\frac{8}{25}$, and $8\frac{12}{35}$.

14. From $8\frac{32}{57}$ subtract $7\frac{72}{95}$.

15. Multiply together $\frac{3}{5}$, $5\frac{7}{9}$, $\frac{8}{39}$, and $11\frac{1}{4}$.

16. Divide $13\frac{14}{15}$ by $22\frac{23}{24}$.

17. Add ·068 of 3 acres 3 roods 15 perches to 1·705 of $20\frac{1}{2}$ square yards, and give the answer in square feet and the decimal of a square foot.

18. Subtract ·0905 of 61 guineas from 2·96 of

65·395 shillings, and give the answer in half-crowns and the decimal of a half-crown.

19. Multiply 1·032796 by ·049.

20. Divide 427·437 by ·26385.

21. Divide ·10378153 by 380·81.

22. If £41 12*s.* be the cost of $100\frac{3}{4}$ gallons of wine, how much is that for 63 gallons 3 quarts $1\frac{1}{2}$ pint?

23. If 15 men can reap a field in $2\frac{1}{2}$ days, how many men could reap the same field in $1\frac{1}{2}$ day?

24. If 3 men or 5 women can reap a field in $25\frac{1}{2}$ hours, in what time could 5 men and 3 women reap it?

25. At what rate per cent. per annum, simple interest, will £1105 amount to £1229 6*s.* 3*d.* in 3 years?

26. By how many inches will 10 feet be represented on a plan in which 26 French mètres, each = 3·28 feet, are represented by $8\frac{1}{2}$ inches?

No. 3.

1. Add together $\frac{5}{12}$, $\frac{5}{14}$, $3\frac{11}{18}$, and $4\frac{10}{21}$.
2. From $18\frac{23}{532}$ subtract $\frac{29}{608}$.
3. Multiply together $\frac{8}{15}$, $\frac{35}{76}$, $\frac{57}{106}$, and $8\frac{29}{56}$.
4. Divide $4\frac{17}{32}$ by $33\frac{7}{20}$.
5. Add together 6·0565, 123·45, 9·576, and 97.
6. From 5·0013 subtract ·90335.
7. Multiply 47·8952 by 47·895.

8. Divide 456 by ·7125.

9. Add together ·0475 of £47 5*s.* and 2·605 of $3\frac{1}{2}$ guineas, and give the answer in florins and the decimal of a florin.

10. Find the value of 37 sq. yds. 8 ft. 98 in. at 3*s.* 9*d.* per square yard.

11. Reduce 17682031 square inches to acres, roods, &c.

12. Find the simple interest on £1357 for 4 years 7 months, at $4\frac{1}{4}$ per cent. per annum.

13. Add together $7\frac{9}{20}$, $5\frac{11}{30}$, $3\frac{13}{45}$, and $1\frac{1}{63}$.

14. Subtract $1\frac{25}{552}$ from $2\frac{21}{506}$.

15. Multiply together $\frac{15}{56}$, $2\frac{16}{87}$, $4\frac{17}{90}$, and $6\frac{18}{95}$.

16. Divide $12\frac{3}{4}$ by $456\frac{7}{8}$.

17. Add ·3456 of 3 mi. 5 fur. $31\frac{1}{2}$ po. to 17 po. 4 yds. $2\frac{1}{4}$ ft., and give the answer in yards.

18. Subtract ·0396 of a square yard from ·396 of 1 ac. 3 ro. 31 po. 30 yds., and give the answer in square yards.

19. Reduce $\frac{88}{145}$ and $\frac{6033}{71000}$ to approximate four-place decimals.

20. Find to the nearest five-place decimal the quotient of ·00018686 divided by ·0459.

21. Divide $\cdot 5\dot{1}2\dot{1}9\dot{5}$ by $\cdot\dot{5}4\dot{0}$, and express the result as a vulgar fraction in lowest terms.

22. In what time will £43 16*s.* 3*d.* amount to £44 10*s.* $10\frac{1}{2}$*d.* by simple interest at 4 per cent. per annum?

23. If 36 men can do a certain quantity of work

in 10 days, how much of that quantity could 30 men do in 9 days?

24. When $6\frac{1}{4}$ days are required for 7 men to perform $\frac{5}{9}$ of a piece of work, how many days are required for 6 men to perform $\frac{4}{7}$ of it?

25. Find the simple interest on £63 17*s.* 6*d.* for 60 days, at $3\frac{3}{4}$ per cent. per annum.

26. By what length is 50 feet represented on an English scale corresponding with a French scale of 3 mètres to an inch? [A mètre = 3·28 feet.]

No. 4.

1. Add together $6\frac{3}{8}$, $10\frac{1}{9}$, $13\frac{7}{10}$, and $\frac{7}{15}$.

2. From $91\frac{6}{91}$ subtract $65\frac{11}{65}$.

3. Divide ·92254 by ·0965.

4. Divide ·742819 of a square yard by ·30695 of an acre.

5. Reduce $\frac{65}{243}$ and $\frac{2}{355}$ to approximate five-place decimals.

6. The capacity of a cistern is 140 cubic feet. How many gallons and tenths of a gallon can it hold, reckoning a gallon = 277·274 cubic inches?

7. Reduce 2 ac. 3 ro. $13\frac{1}{2}$ per. to the nearest six-place decimal of 30 ac. 2 ro. 17 per.

8. A rectangular field is 1825 links in length, and its area is 18 ac. 1 ro. 20·44 per. What is its breadth?

9. Add ·7065 of 17 guineas to ·7065 of £1 13*s.* 4*d.*, and give the answer in half-crowns and the decimal of a half-crown.

10. Find a sum of money such that, when first $\frac{1}{8}$ of it is spent, and then also $\frac{3}{7}$ of the remainder, there may be left two half-crowns.

11. Express as a vulgar fraction in simplest terms the value of $\cdot 11\dot{1}4\dot{7} \div \cdot 1\dot{3}0\dot{0}\dot{7}$.

12. Simplify (i.) $\dfrac{\frac{18}{19} \text{ of } (6\frac{5}{6} - 2\frac{7}{8})}{1\frac{1}{2} + 2\frac{1}{3} + 3\frac{1}{4}}$; (ii.) $\dfrac{4\frac{3}{7} \text{ of } 18\frac{2}{3}}{\frac{4\frac{1}{2}}{5\frac{1}{4}} \div 4{\cdot}128}$.

13. In 11761054 square inches how many acres, roods, &c.?

14. The value of 26·4 yards of silk being given £6 14*s.*, find, in shillings, pence, and the nearest three-place decimal of a penny, the value of 4·26 yards.

15. How often could ·328 be successively subtracted from 5·02004? and what would the final remainder be?

16. A's money is equal to 3·7025 of B's, and B's equal to 2·478 of C's. Find the nearest three-place decimal that C's money is of A's.

17. A bag contains a number of coins, viz. half-crowns, florins, shillings, and sixpences, in value amounting to £15 16*s.*; the half-crowns are $\frac{1}{12}$ of the whole number, the florins $\frac{1}{5}$, and the shillings $\frac{7}{10}$. How many sixpences are there?

No. 5.

1. Add together $3\frac{7}{36}$, $\frac{5}{27}$, $9\frac{9}{20}$, and $13\frac{2}{15}$.

2. From $99\frac{107}{440}$ subtract $8\frac{113}{360}$.

3. Simplify $\frac{4\cdot4 + 5\cdot75}{\cdot2784} \times \cdot07 \times \left(\frac{1}{1\cdot42} - \frac{1}{35\cdot5}\right)$

4. Divide ·011067 by 1·02.

5. Divide $1\cdot44\dot{0}\dot{5}$ by $\cdot43\dot{4}\dot{8}$.

6. Find the simple value of

$$\left(\tfrac{2}{13} + \tfrac{3}{14} + \tfrac{4}{15} + \tfrac{5}{16}\right) \times \tfrac{6}{17}.$$

7. Reduce ·7486 of 9 oz. 13 dwt. to ounces and the nearest three-place decimal of an ounce.

8. What decimal of £15 is 13*s.* $8\frac{3}{4}$*d.*?

9. Show by reduction to decimal form which of the two fractions $\frac{77}{925}$ and $\frac{307}{385}$ is the greater.

10. Simplify $\dfrac{\frac{5}{6} \text{ of } 5\frac{1}{2} - \frac{2}{5} \text{ of } 3\frac{5}{7}}{\frac{1}{12} \text{ of } (6\frac{5}{8} - \frac{4}{7})}$.

11. Reduce ·02483 of 29 sq. yds. 7 ft. 71 in. to square inches and the nearest four-place decimal of a square inch.

12. Add together $\frac{13}{17}$ of 1 cwt. 3 qrs. 15 lb. and 1·609 of $27\frac{1}{2}$ lb., and give the answer in lb. and the decimal of a lb.

13. In 189625 inches how many miles, furlongs, poles, &c.?

14. Divide 158·76 ounces troy by 30·051 ounces avoird. [A lb. avoird. = 7000 troy grains.]

15. Find the value of 3·1416 acres of land, at the rate of £234 7*s.* 6*d.* for 11 ac. 2 ro. 8 per.

16. A can perform a piece of work in $\frac{16}{17}$ of an hour, B the same in $\frac{24}{25}$ of an hour; in what time could it be done by the two agents working together?

17. I drew a certain sum of money from bank this morning, and, in the course of the day, I paid $\frac{2}{3}$ of it to A, $\frac{6}{8}$ of the remainder to B, and $\frac{2}{3}$ of what then remained to C. I have now just a guinea left. What sum was drawn from bank?

No. 6.

1. Add together $6\frac{8}{85}$, $7\frac{9}{68}$, $8\frac{8}{51}$, and $5\frac{7}{60}$.

2. From $97\frac{73}{407}$ subtract $73\frac{97}{222}$.

3. Simplify $\dfrac{\frac{11}{8}\text{ of }(5\frac{5}{8}-2\frac{5}{9})}{3\frac{1}{4}\cdot 3\frac{1}{3}+4\frac{1}{4}+5\frac{1}{8}}$.

4. Divide 70·411 by ·25604.

5. Divide ·999630 by ·586$\dot{3}$.

6. Find the simple value of $\frac{151}{201}-\frac{67}{938}+\frac{13}{412}$.

7. Express the value of £214 12*s.* 2½*d.* in half-crowns and the nearest four-place decimal of a half-crown.

8. What decimal is £407 8*s.* 9*d.* of £848?

9. Show by reduction to decimal form which of the two fractions $\frac{340}{999}$ and $\frac{373}{1098}$ is the greater.

10. Simplify $\frac{4}{7}$ of $(\frac{4}{11}+\frac{7}{12}+\frac{3}{13})\times\dfrac{3\frac{2}{3}}{5\frac{1}{8}-\frac{2}{7}}$

11. Reduce by practice 8·6515 of 17*s.* 8½*d.* to

pounds and the nearest five-place decimal of a pound.

12. From ·775 of 24 cubic feet 74 inches subtract ·0567 of 1 cubic yard 6 feet 60 inches, and give the answer in cubic inches and the decimal of a cubic inch.

13. In 3055731 square inches how many roods, perches, &c.?

14. Express 4*s.* 10*d.* as the nearest five-place decimal of 3 guineas.

15. If 13·1365 tons of coal be worth £15 4*s.* 7*d.*, what is the value of 16 cwt. 1 qr. 13 lb?

16. A, B, and C are engaged to finish a piece of work; A by himself could perform the task in 3 hrs. 23 min., B in 2 hrs. 25 min. In what time would it be done by the three, if C's expertness be equal to $\frac{5}{6}$ of B's?

17. If a piece of ground measuring 1 ac. 1 ro. 22 per. were divided into three allotments, the second $\frac{15}{38}$ of the size of the first, and the third $\frac{21}{40}$ of that of the second, what would be the extent of each allotment in square yards?

No. 7.

1. Add together $2\frac{1}{20}$, $3\frac{25}{42}$, and $4\frac{19}{70}$.

2. From $21\frac{24}{493}$ subtract $12\frac{19}{306}$.

3. Simplify $\frac{1\frac{23}{45} \text{ of } 20\frac{1}{4}}{3\frac{45}{67} \text{ of } 21\frac{3}{4}} \times \frac{\cdot 0123}{6\cdot 7}$; and reduce the result to its decimal equivalent.

4. Divide ·1479 by ·00348.

5. Divide $7{\cdot}77\dot{2}5\dot{9}$ by 14·99.

6. Find the simple value of

$$\tfrac{7}{13} + \tfrac{8}{15} - (\tfrac{7}{13} \times \tfrac{8}{15} \times \tfrac{9}{14}.)$$

7. Reduce ·0884 of 13 cwt. 3 qrs. 27 lb. to ounces and the decimal of an ounce.

8. What decimal of 3 days 25 min. is 56 hrs. 43 min. 35 sec.?

9. Reduce to five-place decimals $\frac{29}{55}$ and $\frac{1}{3855}$.

10. Simplify $\frac{7\frac{4}{5}}{8}$ of $\frac{\cdot 0\dot{3}\dot{6} + 4{\cdot}4\dot{8}}{5\frac{1}{3} \times 5\frac{1}{4} + 5\frac{1}{5}}$

11. Find in lowest terms a vulgar fraction of $22\frac{1}{3}$ guineas equal to ·2345 of 6*s.* $7\frac{1}{2}$*d.*

12. From $\frac{3}{14}$ of 7 oz. 11 dwt. 9 grs. subtract ·8064 of 14 dwt. 15 grs., and give the answer in ounces and the decimal of an ounce.

13. From 19 sq. po. 29 yds. 1 ft. 40 in. subtract 30 sq. yds. 1 ft. 90 in.

14. Multiply 2 ft. 10·35 in. by 3·075, and give the answer in yards and the decimal of a yard.

15. If 477 navvies can finish a piece of work in $8\dot{5}$ hours, how many could perform the same task in $\frac{£3\ 7s.\ 6{\cdot}9d.}{16s.\ 3\frac{1}{2}d.}$ of 19 hrs. 33 min.

16. A and B, working together, can do in $3\frac{1}{3}$ days an amount of work which A by himself could do in $7\frac{1}{2}$ days; in what time could B alone do it?

17. The joint capital of three partners, A, B, C, is £2030; but if A had contributed 3 times as much

as he did, B 4 times, and C $4\frac{1}{2}$ times, their investments would have been equal. What is the amount of each capital?

No. 8.

1. Find the sum of $\frac{3}{5}+6\frac{5}{12}+\frac{8}{15}+8\frac{9}{20}$.

2. Find the value of $10\frac{1}{3}\frac{8}{6}\frac{8}{5}-\frac{1}{5}\frac{1}{8}\frac{1}{4}$.

3. Simplify $\dfrac{7\frac{3}{7}+5\frac{5}{8}-\frac{3}{8}\text{ of }13\frac{1}{2}}{5\frac{1}{3}\text{ of }13\frac{1}{2}+\frac{8}{15}-\frac{3}{4}}$.

4. Divide ·679394 by 1·48.

5. Multiply 62·1089 by ·73176.

6. Divide the product of $\frac{1}{2}\frac{3}{5}$ and $\frac{1}{16}$ by the difference of $\frac{1}{2}\frac{1}{8}$ and $\frac{1}{3}\frac{7}{5}$.

7. Reduce £90 16*s.* 11*d.* to guineas and the nearest three-place decimal of a guinea.

8. Reduce 3 ro. 19 per. 13 yds. 5 ft. to the nearest five-place decimal of an acre.

9. Reduce to decimals $\dfrac{10s.\ 2\frac{1}{2}d.}{£3\ 17s.}$ and $\dfrac{6\text{ cwt. }3\text{ qrs.}}{12\text{ tons }7\frac{1}{2}\text{ cwt.}}$.

10. Simplify $\dfrac{2+\frac{8\frac{3}{4}}{9\frac{3}{8}}-\frac{9\frac{1}{2}}{10\frac{4}{5}}}{5+\frac{1}{9}^{0}-\frac{9}{10}}$.

11. Reduce ·5355 of £1 13*s.* 10*d.* to the decimal of a guinea.

12. Add $\frac{6}{19}$ of half-a-crown to ·3456 of £1 15*s.* $8\frac{1}{2}d.$, and give the answer in shillings and the nearest four-place decimal of a shilling.

13. In 217310 inches how many miles, furlongs, poles, &c.?

14. Divide 6 cwt. 3 qrs. 13·58 lb. by 58·13, and find the answer as the nearest five-place decimal of a ton.

15. If $\frac{2}{3}\frac{8}{5}$ of $\frac{5}{4}\frac{5}{6}$ of 55 gallons of oil weigh 3 cwt. 1 qr. 13 lb., what is the weight of 1·936 of $21\frac{1}{2}$ gallons?

16. An empty cistern has two supply pipes, one of which alone can fill it in $3\frac{4}{7}$ hours, and the other in $3\frac{3}{4}$ hours; it has also a discharge pipe which can run off the full contents of the cistern in $1\frac{1}{2}$ hour. If when the cistern is full the three pipes are turned on, in what time will it be empty?

17. What three sums of money, amounting together to £152, are such, that 3 months' interest on the first equals 4 months' interest on the second, and that 5 months on the second equals 6 months on the third?

No. 9.

1. Find the sum of $1\frac{3}{6}\frac{7}{8}+2\frac{7}{7}\frac{7}{2}+3\frac{2}{1}\frac{3}{5}\frac{3}{3}$.

2. Find the difference of $9\frac{2}{2}\frac{2}{1}$ and $14\frac{2}{3}\frac{2}{5}$.

3. Simplify $\dfrac{\frac{1}{1}\frac{8}{9}+\frac{1}{2}\frac{9}{0}}{3\frac{1}{1}\frac{5}{8}-\frac{1}{1}\frac{4}{5}}$.

4. Divide ·012304 by 5·67 to the fifth place of decimals.

5. Divide $113\cdot\dot{6}\dot{1}$ by $\cdot1\dot{4}0\dot{7}$.

6. Find the simple value of

$$\frac{2}{2}\frac{8}{9}\text{ of }(4\tfrac{1}{2}\tfrac{1}{0}+5\tfrac{1}{4}\tfrac{1}{0}-6\tfrac{1}{1}\tfrac{1}{4}).$$

7. Express 2·0936 of 3 common years 252 days 15 hours in common years and the nearest five-place decimal of a common year.

8. Reduce 2 fur. 27 yds. 2·35 ft. to the nearest six-place decimal of 26 mi. 6 fur. 104 yds.

9. Reduce to four-place decimals—

$$\frac{\text{39 sq. yds. 3 ft. 9 in.}}{\text{1 ac. 2 ro. 35 per.}} \text{ and } \frac{\text{28 qu. 6 bu. 0·7 pks.}}{\text{8 qu. 5 bu. 2·3 pks.}}$$

10. Simplify $\frac{9\frac{1}{8} + 8\frac{1}{9} - 7\frac{1}{10}}{\frac{1}{8} - \frac{1}{9} + \frac{1}{10}}$.

11. Reduce by Practice 7·805 of 23 hrs. 43 min. to weeks and the nearest five-place decimal of a week.

12. Multiply 5 ac. 26 per. by

$$\frac{13s.\ 10\frac{1}{2}d.}{14s.\ 6d.} \text{ of } \frac{\text{4 qu. } 4\frac{1}{4} \text{ bu.}}{\text{9 qu. } 1\frac{3}{4} \text{ bu.}}$$

13. In 14810603 square inches how many acres, roods, perches, &c.?

14. If 1·7391 of 3 oz. 14 dwt. 16 grs. of silver be worth £1 11*s.*, what is the value of ·875 of 15 dwt. 14 grs.?

15. There are two rectangular fields equal in area; the length of one is equal to $\frac{\text{17 yds. 8 in.}}{\text{19 yds. 2 ft. 5 in.}}$ of 897 yards, and its breadth equal to $\frac{£53\ 11s.}{£63\ 15s.}$ of $\frac{\text{2477 yds. 3 in.}}{3\frac{1}{3} + 4\frac{1}{4}}$; what is the length of the other field, the breadth of it being 287 yards?

16. In what time can A, B, and C jointly build a wall, which B could build by himself in $28\frac{3}{4}$ days,

or along with A in $12\frac{10}{33}$ days, or along with C in $13\frac{13}{21}$ days?

17. Divide the quantity 35·73 into four parts, so that $\frac{3}{5}$ of the first, $\frac{3}{7}$ of the second, $\frac{5}{8}$ of the third, and $\frac{4}{9}$ of the fourth, shall be equal quantities.

No. 10.

1. Add together $21\frac{13}{21}$, $16\frac{2}{35}$, $40\frac{6}{45}$, and $12\frac{5}{63}$.

2. From $10\frac{13}{114}$ subtract $\frac{31}{133}$.

3. Simplify $\dfrac{1\frac{1}{2} \text{ of } 19\frac{3}{7} \div \frac{1}{6}}{1\frac{1}{4} + 19\frac{3}{7} + \frac{1}{6}}$

4. Divide 1 by 1·0203 to six places of decimals.

5. Multiply ·65$\dot{7}$ by 51·08$\dot{1}$.

6. Find the simple value of

$$516\left(\tfrac{1}{33} - \tfrac{1}{66}\right) + 133\left(\tfrac{1}{65} - \tfrac{1}{91}\right).$$

7. Reduce, approximately, ·0005787 of a cubic foot to cubic inches, and ·076 of 3·655 of a cubic yard to cubic feet.

8. Reduce 2 cwt. 1 qr. 18 lb. to the nearest six-place decimal of a ton.

9. Reduce to five-place decimals $\dfrac{603\frac{1}{8}}{2058\frac{2}{3}}$ and $\dfrac{61\frac{2}{13}}{20\frac{20}{21}}$

10. Simplify $\dfrac{\frac{11}{28} + \frac{5}{36} + \frac{13}{42} + \frac{10}{63}}{4\frac{7}{12} + 5\frac{9}{52} + \frac{19}{78}}$

11. What vulgar fraction of ·805 of 4 bu. $3\frac{1}{2}$ pks. is equal to ·0845 of 15 bu. 3 pks.?

12. From ·2478 of 4 ac. 1 ro. 25 per. subtract $\dfrac{5\frac{3}{7} - 2\frac{3}{8}}{4\frac{1}{3} + 7\frac{3}{7}}$ of 3·51 roods, and give the answer in perches and the decimal of a perch.

13. In 14701500 square inches how many acres, roods, perches, &c.?

14. Find the greatest common measure of 133 cwt. 3 qrs. 11·45 lb. and 157 cwt. 1 qr. 25 lb.

15. A piece of work can be finished by a certain number of men in ·9559 of 22 hrs. 24 min.; how much less or more than the number would be necessary to finish it in ·948 of 25 hrs. 40 min.?

16. A, B, and C can finish a certain piece of work in 2 hrs. 5 min.; in what time could each by himself do the whole, supposing that B singly would take one-fourth as long again as A, and that C singly would take one-third as long again as B?

17. Into what three numbers of yards must a mile be divided, so that 7 times the first shall equal 6 times the second, and that 9 times the second shall equal 7 times the third?

PART SECOND.

Proportion, Practice, and Percentages.

No. 1.

1. If 679 sq. yds. 7 ft. of asphalte paving cost £410 11*s.*, what extent of it costs £80 15*s.*?

2. If 5 men could finish a piece of work in $7\frac{1}{2}$ hours, how many men could finish it in $4\frac{1}{2}$ hours?

3. If £30 7*s.* 9*d.* be the value of 10 cwt. 2 qrs. 14 lb. of cotton, what is the value per cwt.?

4. If 19 gall. 3 qts. $1\frac{3}{4}$ pt. of spirits be worth £18 12*s.* 9*d.*, what quantity is worth 15 guineas?

5. If the estate of a bankrupt yielded £384 8*s.* 11*d.*, his debts amounting to £1255 6*s.* 8*d.*, how much would a creditor receive whose claim was £19 6*s.* 8*d.*?

6. British gold coin being worth £3 17*s.* $10\frac{1}{2}$*d.* an ounce, find to the nearest grain the weight of 22 sovereigns.

7. On what income is £3 8*s.* 3*d.* charged for income tax, when the rate is 5*d.* in the pound?

8. Calculate by Practice—

(i) 437 things at 11*s.* $10\frac{1}{2}$*d.*

(ii) 293 things at £3 17*s.* 9*d.*

(iii) A dividend of 6*s.* 10*d.* in the pound on £385 12*s.* 6*d.*

9. Calculate, to the nearest penny, $3\frac{1}{2}$ per cent. discount on £29 12*s.* 8*d.*

10. What shall I gain per cent. by selling silk at 4*s.* 6*d.*, which costs me 3*s.* 9*d.* a yard?

11. A person sells for 3 guineas a quantity of stationery that cost him £4 10*s.*; what is his loss per cent.?

12. What rate per cent. discount will reduce £408 11*s.* 6*d.* gross to £395 6*s.* nett?

13. With 20 gallons brandy, bought at 19*s.* 6*d.* a gallon, a merchant mixes $2\frac{1}{2}$ gallons of water; at what must he sell the mixture per gallon to gain $18\frac{3}{4}$ per cent.?

14. What is a person's gross income, if it became £238 6*s.* $9\frac{1}{2}$*d.* nett by deduction of 7*d.* in the pound income tax?

15. On the gross amount of an invoice a discount of $1\frac{1}{4}$ per cent. was allowed, the nett amount, calculated to the nearest penny, being £17 9*s.* 1*d.*; what was the gross amount?

16. If a salesman gain $7\frac{1}{5}$ per cent. by selling bacon at 83*s.* 9*d.* a cwt., what did it cost him?

17. One piece of silk measuring $48\frac{3}{4}$ yards cost 10 guineas, another measuring $52\frac{1}{2}$ yards cost £11 7*s.* 6*d.* Express in simplest terms the ratio of the prices per yard.

18. Find the present worth of £46, payable 6 months hence, interest being at 7 per cent. per annum.

No. 2.

1. A bankrupt's liabilities amounted to £647 15*s.*, and his assets to £205 2*s.* 5*d.*; how much could he pay in the pound?

2. In what time could 16 men perform a piece of work which 12 men can perform in 9 days?

3. How much tea at 3*s.* 3*d.* a lb. is equal in value to 4 lb. 7½ oz. of coffee, if 5½ lb. of coffee be worth 7*s.* 9*d.*?

4. Standard gold is 22 carats, or $\frac{22}{24}$, fine, and an ounce of it is worth £3 17*s.* 10½*d.*; what is the worth of an ounce of jeweller's gold, which is 18 carats, or $\frac{18}{24}$, fine? and what is the worth of an ounce of pure gold?

5. How much water must be mingled with 42 gallons of rum, worth 16*s.* 6*d.* a gallon, to reduce the value to 15*s.* 9*d.*?

6. If a person's gross income be £756 15*s.*, to what nett income will it be reduced by an income tax of 5*d.* in the pound?

7. Find the true discount on £43 6*s.* 10½*d.*, due 4 years hence, reckoning simple interest at 3½ per cent. per annum.

8. Calculate by Practice—

(i) 387 things at 17*s.* 3¾*d.*

(ii) 1095 things at £1 13*s.* 8*d.*

(iii) A loss on £276 11*s.* 6*d.* at 2*s.* 11*d.* in the pound.

9. If an income tax of 5*d.* in the pound reduces a person's gross income to £232 13*s.* nett, what is the gross amount?

10. By selling goods for £49 17*s.* 4*d.* I lost 6⅔ per cent.; what did they cost me?

11. A grocer mixes 15 lbs. of tea at 2*s.* 10*d.* a lb. with 18 lb. at 3*s.* 9*d.* at what price per lb. must he sell the mixture to gain 7½ per cent.?

12. Bought 25 gallons rum at 15*s.* 10*d.*, and have sold 20 gallons at 17*s.*; at what price must I sell the remaining 5 gallons to clear 8 per cent. on the whole?

13. By selling umbrellas at a guinea I gain 12½ per cent.; what should I gain or lose per cent. if I sold them at 19*s.*?

14. Of 150 dozen wine glasses, which cost me 5*s.* 4*d.* a dozen, I sold 35 dozen at 6*s.* and 45 dozen at 6*s.* 4*d.*; but I was obliged to sell the remainder at 4*s.* 6*d.* a dozen. What was my gain or loss per cent. on the whole?

15. The areas of three contiguous fields are in the proportion of 2¼, 2½, and 3½, and they together make up an acre; find, in roods, perches, yards, the area of the smallest field.

16. A certain piece of work can be done by 21 men in 26 days. If, after they have wrought 11 days, 6 men are added to their number, in what time will the remainder of the work be done?

17. Compare in simple terms the speed of two trains, one of which runs 17 m. 4 fur. 32 yds. in 39⅛ minutes, and the other 28 m. 6 fur. 35 yds. in 1¼ hour.

18. What principal would amount to £965 3*s.* 8*d.* by simple interest, in 3 years, at 4 per cent. per annum?

No. 3.

1. If 17 yds. 2 ft. 10 in. of tubing is worth 17*s.* 5*d.*, how much of it is worth 10*s.* 6½*d.*?

2. When £2 19*s.* 3*d.* is charged for a quarter's consumption of gas, at 3*s.* 9*d.* per thousand cubic feet, for how many feet is the charge made?

3. If 60 bricks weigh 296 lb., and cost at the rate of 27*s.* 6*d.* a thousand, what will be the cost of a load weighing 13 cwt. 3 qrs. 14 lb.?

4. Find the simple interest on £2537 10*s.* 6*d.*, for 235 days, at 4½ per cent. per annum.

5. When £21 15*s.* is the simple interest on £203 for 2½ years, what principal, at the same rate, would bear £65 interest in 4⅓ years?

6. A merchant bought a quantity of spirits at 19*s.* 6*d.* a gallon, and added to it so much water as increased the quantity to 52 gallons, and reduced the price per gallon to 18*s.* What quantity did he buy?

7. If four persons, A, B, C, D, contribute in the proportion of their incomes to make up a donation of £100, what is given by each, reckoning A's income to be £260, B's £285, C's £345, and D's £360?

8. Calculate by Practice—

(i) 1546 articles at 2*s.* 8¾*d.*

(ii) 347 articles at £2 18*s.* 10*d.*

(iii) A profit of 4*s.* 10*d.* per pound on £117 16*s.* 8*d.*

9. Reckoning 3 bullocks to be worth as much as 28 sheep, what is the value of 455 sheep,—that of 13 bullocks being £270?

10. If chairs bought at *2s.* 4*d.* each are sold at *1s.* 10*d.*, what is the loss per cent.?

11. A draper bought 102 yards of silk at a uniform price per yard, and by selling 40 yards at *4s.* 3*d.* a yard and 51 yards at *4s.* 4*d.* he exactly recovers his whole outlay. What did the silk cost him per yard? and what will he gain per cent. by selling the remaining 11 yards at *4s.*?

12. If 11 gallons of brandy and 10 of wine together cost £15, what cost 4 gallons of brandy and 7 of wine, the brandy being twice as dear as the wine?

13. A merchant sold 8 gallons of spirits at *16s.* 7*d.* a gallon, 7 at *13s.* 6*d.*, and 2 at *19s.* 7*d.*, and gained thereby $5\frac{3}{4}$ per cent. Find the average prime cost per gallon.

14. A bankrupt's estate yielded *9s.* 7*d.* in the pound; what was the amount of a creditor's claim whose share of the assets was £216 *17s.* 5*d.*?

15. If 30 men can do a piece of work in 16 days, and, after they have wrought 9 days, 9 of them are sent away, in how many days will the whole work be done?

16. If £244 could buy, either 11 bullocks and 7 sheep, or 2 bullocks and 90 sheep, what are the prices per head?

17. One kind of wheat is worth *6s.* $10\frac{1}{2}$*d.* a bushel, another is worth *6s.* 5*d.* State in simplest terms the ratio that any given quantity at the higher price bears to an equivalent quantity at the lower.

18. What principal would in 3 years amount to £386 *17s.* 9*d.* by simple interest at $6\frac{1}{4}$ per cent. per annum?

No. 4.

1. Find the simple interest on £328 15*s.* for 292 days at $3\frac{1}{8}$ per cent. per annum.

2. A gives B a salmon weighing 11 lb. 13 oz., valued at 1*s.* 8*d.* per lb., in exchange for $22\frac{1}{2}$ lb. of bacon. At what price per lb. is the bacon valued?

3. If the price of the 4 lb. loaf should be $7\frac{1}{2}$*d.* when wheat is 55*s.* 10*d.* a quarter, what should it cost when wheat is 61*s.* 5*d.*?

4. Calculate $\frac{1}{8}$ per cent. commission on £1370, and $1\frac{1}{4}$ per cent. discount on £563.

5. If 14 men can excavate 272 cubic yards of clay in 2 days, in what time can 15 men excavate 255 yards?

6. A block of marble which contains 6 cubic feet 160 inches, and weighs 9 cwt. 26 lb., is reduced by being shaped to 3 cubic feet 1704 inches, what is the reduced weight?

7. What sum would bear £30 10*s.* 8*d.* simple interest in 1 year 11 months, if the rate were $3\frac{1}{8}$ per cent. per annum?

8. Calculate by Practice—
   (i) 1056 yards at 1*s.* $10\frac{1}{2}$*d.*
   (ii) $145\frac{3}{8}$ acres at £7 11*s.* 8*d.*
   (iii) The cost of paving a court, 57 ft. 6 in. long and 45 ft. 9 in. wide, at 4*s.* 6*d.* per square yard.

9. When 52 bushels of wheat of average quality are worth £17 11*s.*, what is the value of 62 bushels of one-third better than average quality?

10. If I buy 12 reams of foolscap paper at 11*s.* 6*d.*, and 63 reams of note paper at 3*s.* 10*d.*, and am allowed 3 months' credit, what is the present value of my purchase, reckoning the credit to be worth $2\frac{1}{2}$ per cent. per annum?

11. What is the true discount on £212, due 150 days hence, interest being 4 per cent. per annum?

12. If 9 lb. of tea cost as much as 14 lb. of coffee, and $8\frac{1}{4}$ lb. of tea cost as much as 49 lb. of sugar, how many lb. of sugar will cost as much as $5\frac{1}{2}$ lb. of coffee?

13. On the amount of an invoice $2\frac{1}{2}$ per cent., calculated to the nearest penny, was allowed for immediate payment, making the nett amount £23 4*s.* 4*d.* What was the gross amount?

14. The assets of a bankrupt, amounting to £273 14*s.* 4*d.*, yield 5*s.* 4*d.* in the pound to his creditors. What was the amount of his debts?

15. I bought 57 gallons of rum at 16*s.* 8*d.*, and, after adding to it 7 gallons of water, I was obliged to sell the mixture at a loss of 4 per cent. Find the selling price per gallon of the diluted spirits.

16. I have gained 8 per cent. by selling goods for £25 13*s.*; what should I have gained or lost per cent. by selling them for £24?

17. Compare the prices per lb. of mutton and salmon, when two legs of mutton, weights 11 lb. 12 oz. and 12 lb. 11 oz. together cost as much as 14 lb. $5\frac{1}{2}$ oz. of salmon.

18. When £77 17*s.* 4*d.* amounts to £78 8*s.* by simple interest in 50 days, what principal, at the same rate, will amount to £76 9*s.* 7*d.* in 42 days?

No. 5.

1. A bankrupt's liabilities amount to £4873 16*s.*, and his assets to £1929 4*s.* 3*d.*; how much can he pay in the pound?

2. If 6 horses eat 217 stone of hay in 16½ days, how long will 527 stone last 15 horses?

3. If ⅓ of a gallon of brandy cost as much as ⅛ of a cwt. of sugar, and 9 gallons of brandy cost as much as 8 tons of coals, how many cwt. of sugar cost as much as 10 tons of coals?

4. Divide the number 999 into two parts in proportion as $3\frac{5}{8}$ and $9\frac{3}{8}$.

5. If 6 men of ¼ better than ordinary expertness build a wall in 16 days, in what time would 5 men of ⅓ less than ordinary expertness do it?

6. In what time will £212 17*s.* be the simple interest on £2580, at 3 per cent. per annum?

7. How much in the pound income-tax would reduce a gross income of £763 5*s.* to £750 10*s.* 7*d.* nett?

8. Calculate by Practice—

(i) 470 things at £1 12*s.* 1*d.*

(ii) 383 things at 12*s.* 8½*d.*

(iii) A dividend on £97 11*s.* 8*d.* at 5*s.* 4*d.* in the pound.

9. Find the present worth of £59 14*s.*, due 84 days hence, interest being at $3\frac{3}{4}$ per cent. per annum.

10. If 14 gall. 2 qts. $1\frac{7}{8}$ pts. of rum cost £11 10*s.*, for what sum must 7 gall. 2 qts. 1½ pt. of it be sold to gain 7½ per cent.?

11. A merchant bought 16 puncheons of brandy at 207 francs per puncheon, and has sold 11 puncheons of it at 231 francs; at what price must he sell the remainder to gain 12½ per cent. on the whole?

12. How long hence is £238 18*s.* 4*d.* due, if its present worth be £203 6*s.* 8*d.*, interest being reckoned at 5 per cent. per annum?

13. What principal, at 4¼ per cent. per annum, simple interest, will in 4 years amount to £561 4*s.* 8½*d.*?

14. With what quantity of spirits worth 19*s.* 10*d.* a gallon may 2¾ gallons of water be mingled, to reduce the value per gallon to 18*s.*?

15. A besieged garrison had a quantity of provisions sufficient for 6 weeks, if distributed at 10 ounces to each man per day; but, having lost 630 men in a sally, the governor was enabled to increase the allowance to 12 ounces a day for 8 weeks. How many men were at first in the garrison?

16. If 3 peasants, or 4 soldiers, can excavate 21 cubic yards of earth for an entrenchment in a day of 8½ hours, in what time should 7 peasants and 9 soldiers excavate 64 cubic yards, supposing the soil, in the latter case, less favourable to expertness by one-fifth?

17. If 9¼ per cent. would be gained by selling wheat at 6*s.* 4*d.* a bushel, at what price must it be sold to gain 15 per cent.?

18. By selling a piece of silk at 4*s.* a yard a draper lost 8 per cent.; what would he have gained or lost per cent. by selling it at 4*s.* 6*d.*?

No. 6.

1. The simple interest on a certain sum is found to be £16 8*s.* 6*d.* at the end of 342 days; what was it at the end of 247 days?

2. What quantity of gold that is 22 carats fine is equal in value to 8 oz. 1 dwt. 8 grs. of gold that is 18 carats fine?

3. What rate of discount is allowed, when £15 9*s.* 5*d.* is accepted as payment for goods invoiced at £15 13*s.* 4*d.*?

4. What is the present worth of £32 15*s.* 11*d.*, due $3\frac{1}{2}$ years hence, reckoning simple interest at $4\frac{1}{2}$ per cent. per annum?

5. In what time would £8 10*s.* be the simple interest on £283 6*s.* 8*d.*, at $8\frac{1}{3}$ per cent. per annum?

6. A toy merchant sells an article at the rate of 25 for 32*s.* 6*d.*, which cost him 13*s.* 6*d.* a dozen; what does he gain per cent.?

7. Divide £1011 into three sums proportioned as the distances 15 ft. 6 in., 24 ft. $4\frac{1}{2}$ in., and 30 ft. 4 in.

8. Calculate by Practice—

(i) $567\frac{8}{15}$ yards at 9*s.* $7\frac{1}{2}d.$

(ii) $267\frac{3}{4}$ acres at £3 13*s.* 6*d.*

(iii) The sum lost by a creditor, whose claim on a bankrupt's estate, yielding 7*s.* in the pound, is £57 13*s.* 9*d.*

9. If an ounce of pure gold be worth £4 4*s.* $11\frac{1}{2}d.$, what proportion of alloy (valued at nothing) is there in 7 oz. 14 dwt. of gold worth £24 10*s.* $7\frac{1}{2}d.$?

10. If 85 men can excavate one-half of a mass of earth in $3\frac{1}{2}$ days of 9 hours long, how many hours a day for $4\frac{1}{4}$ days would 70 men be required to work, in order to excavate the other half which is less laborious than the former by one-tenth?

11. A contractor has so many workmen, that a certain piece of work can be accomplished by them in 52 days; but if he had 63 more men it could be done in 40 days. How many men has he?

12. When 40 days' interest on £270 is 13*s.* 4*d.*, on what principal is 14*s.* 3*d.* the interest for 36 days?

13. A stationer would lose $2\frac{1}{2}$ per cent. if he sold paper at 8*s.* 8*d.* a ream: what would he gain per cent. if he sold it at 9*s.* 8*d.*?

14. A draper gains $10\frac{1}{2}$ per cent. by selling lawn at 3*s.* 3*d.* a yard: at what selling price per yard would he gain $6\frac{1}{4}$ per cent.?

15. A person's gross income is reduced to £451 8*s.* 9*d.* nett by a tax of 7*d.* in the pound. Find the gross income.

16. A bankrupt's debts amounted to £2602 12*s.*; and a creditor whose claim was £350 received £182 5*s.* 10*d.* Find the total assets.

17. How much per cent. is cut away from a stone block containing 5 cubic feet 243 inches, to reduce the bulk to 4 cubic feet 655 inches?

18. Compare in direct and simple terms the prices per bottle of three kinds of wine:—2 bottles of the second kind costing as much as 3 of the first, and 5 of the third as much as 6 of the second.

No. 7.

1. If 110 gall. 3 qts. 1½ pt. of oil be worth £23, how much of it is worth £15 10*s.* 6*d.*?

2. The liabilities of a bankrupt amounted to £1827 15*s.*, and his estate realized £670 3*s.* 6*d.*: how much did the creditors get per pound?

3. A goods train is 9 miles ahead of an express train; the latter is running at the rate of 42 miles per hour, and the rate of the former is such that it will be run into in 27 minutes, if there be no alteration of speed. Find the rate per hour of the goods train.

4. If I buy land for a sum equal to 24 times the annual rent of it, what rate of interest per cent. per annum shall I have for my money?

5. How much water added to 31½ gallons of spirits will reduce the worth per gallon from 15*s.* 7*d.* to 14*s.* 10½*d.*?

6. Find the present worth of £1708 5*s.* 7½*d.*, due 3¾ years hence, reckoning simple interest at 4¾ per cent. per annum.

7. At what rate per cent. per annum will £2720 produce £321 6*s.* simple interest in 3½ years?

8. Calculate by Practice—

(i) 279 times 6 cwt. 3 qrs. 16 lb.

(ii) 314 times £5 13*s.* 9*d.*

(iii) £76 14*s.* 8*d.* at 9*s.* 9½*d.* per pound.

9. An agent sells goods for his employer to the amount of £11 13*s.* 5*d.*, on which he is allowed a percentage which, calculated to the nearest penny,

reduces the amount to £11 5*s.* 3*d.* nett. Find the rate per cent.

10. A merchant bequeaths £1400 among five clerks, in proportion to their salaries and periods of service. One has held his situation 5 years, and his salary is £130; two have served for 4 years, with salaries of £100 each, and the remaining two for 2 years, with salaries of £75 each. Find their several shares of the bequest.

11. A merchant having bought 75 lb. of tea, at 3*s.* a lb., sold 35 lb. of it at 3*s.* 2*d.*, and the remainder at such a price as made his gain on the whole 10 per cent. At what price per lb. did he sell the 40 lb.?

12. If a salesman lose $8\frac{1}{8}$ per cent. by selling poultry at 2*s.* 11*d.*, what did it cost him?

13. A salesman buys eggs at the rate of 10 for 9*d.*; at what price must he retail them per dozen to make $4\frac{1}{6}$ per cent. profit?

14. If 5 men earn as much in a day as 9 women, and 2 women as much as 5 boys, and if 6 men, 7 women, and 8 boys, working together, earn 15 guineas in 6 days, what will the earnings of 7 men and 11 women, working together, amount to in 8 days?

15. One piece of silk, measuring $48\frac{3}{8}$ yards, is bought for £9 12*s.* 6*d.*, another, measuring $53\frac{3}{4}$ yards, costs 10 guineas: compare in simple terms the prices per yard.

16. If an allowance of $3\frac{1}{8}$ per cent. discount would reduce the gross amount of an invoice to £100 nett, what would be the nett amount, if $4\frac{5}{12}$ per cent. discount were allowed?

17. A tradesman accustomed to make 10 per cent. profit on an article, which he sold at 5*s.* 10*d.*, is now retiring from business, and selling the same article at 5*s.* 4*d.*; what does he gain or lose per cent. by the reduced price?

18. A poulterer, having bought a number of fowls at 2*s.* 6*d.* each, sold two-thirds of the number at 3*s.* 6*d.* each, and the rest at a loss of 10 per cent. His gain on the whole was 17*s.* 6*d.* How many fowls did he buy?

No. 8.

1. If 73 cwt. 2 qrs. 24 lb. of iron cost £25, what is the cost of 64½ tons?

2. The weight of 22 sovereigns is 5 oz. 13 dwt.; how many sovereigns are coined from 13⅓ lb. of standard gold?

3. If eggs bought at 11½*d.* a dozen are retailed at 9*s.* 7*d.* a hundred, what is gained per cent.?

4. When £15000 amounts to £16620 in 2½ years, by simple interest, what is the rate per cent. per annum?

5. A contractor gained 14 per cent. by selling a quantity of old building material for £20; what did it cost him?

6. Three carmen, A, B, C, earning the same wages, are to have 4¾ tons of coals divided among them, in payment for which A is to give up ⅔ of a week's wages, B ¾, C ⅘. What quantity should each receive?

7. A tobacconist mixes 2 lb. of tobacco, worth 4*s.* 10*d.* a lb., with 13 lb. worth 5*s.* 8*d.* a lb., and sells the mixture at 6*s.* 4*d.*; what does he gain per cent.?

8. Calculate by Practice—

(i) 334 times 7 ac. 2 ro. 25 per.
(ii) 457 times £12 13*s.* 6*d.*
(iii) A loss on £314 16*s.* 8*d.*, at 17 per cent.

9. A garrison was provisioned for 40 days; but after 10 days an additional force of 250 men was sent into the fort, and the provisions were exhausted after 25 more days. How many men were there in the garrison at first?

10. When the weight of 28 bushels of oats is $9\frac{3}{4}$ cwt., and that of 35 bushels of wheat is $17\frac{1}{4}$ cwt., what weight of oats is equal in bulk to 92 lb. of wheat?

11. I have bought 16 gallons of brandy at 18*s.* 5*d.*; how many quarts may I reserve for my private use, so as to recover my outlay by selling the remainder at 19*s.* 6*d.* a gallon?

12. The value of a Russian rouble being equal to $\frac{5}{7}$ of that of a Roman scudo, how many Bombay rupees are equal in value to 128 scudi, reckoning 7 rupees equal to 6 Danish dollars, 33 Danish dollars equal to 25 Prussian dollars, and 12 Prussian dollars equal to 11 roubles?

13. A invests a certain sum in a speculation, and 3 months afterwards is joined by B, who advances as much as makes their joint capital £2000. Six months after this, the partners having occasion to divide a profit of £795, B's share of it is found

to be 200 guineas. What sum was invested by each partner?

14. In what time will £1842 amount to £1945 12*s.* 3*d.*, by simple interest at 7½ per cent. per annum?

15. When one income, of £153, chargeable with income-tax, and another, of £149 3*s.* 6*d.*, exempted from income-tax, are practically equivalent, what is the rate of the tax per pound?

16. When 5 turkeys cost as much as 9 geese, and 7 geese cost 10 shillings more than 3 turkeys, what two equal numbers of geese and turkeys can together be had for £7?

17. By one set of navvies 1000 cubic yards of earth can be excavated in 6 days, by another 840 cubic yards in 5 days; by how much per cent. does the work done per day by the latter set exceed that done by the former?

18. A sells a pianoforte to B with a profit of 16⅔ per cent.; shortly afterwards, B, going abroad, sells it to C, at a loss of 10 per cent., for 30 guineas. What did the instrument cost A?

No. 9.

1. A bankrupt's estate paid his creditors £739 17*s.* 3*d.*, the dividend being only 4*s.* 10*d.* in the pound. How much did he owe?

2. How many bushels of malt would cost £3 7*s.* 2*d.*, at the rate of £7 14*s.* 4½*d.* for 17 bushels 3½ pecks?

3. The original owners of a steamboat having sold out their shares at different times, the present owners, E, F, G, agree to divide a profit of £410 in proportion to the time each has been concerned in the vessel, and the money he advanced, which are as follows:—E £1650 for 14 months, F £1490 for 15 months, G £1400 for 10 months. Required the particular shares of profit.

4. In what time will any sum of money double itself by simple interest, at $6\frac{1}{4}$ per cent. per annum?

5. A wine merchant mixed a quantity of spirits, at 15*s.* a gallon, with five times as much at 16*s.* 6*d.*:—what did he gain per cent. by selling the mixture at 17*s.* 4*d.*?

6. A road, half a mile long, is to be made in 15 weeks, and 30 men are employed on it, working 9 hours a day; but at the end of 5 weeks it is found that only 240 yards are finished; how many *additional* men must be put on, so that, all working 10 hours a day, the road may be completed in the specified time?

7. Calculate the true discount on a bill for £395, which has 107 days to run, reckoning interest at $2\frac{3}{4}$ per cent. per annum.

8. Calculate by Practice—

(i) 1085 gallons, at 15*s.* 8*d.* a gallon.
(ii) 785 gallons, at 12*s.* 1*d.* a gallon.
(iii) £390 9*s.* 10*d.* at 6*s.* $10\frac{1}{2}$*d.* in the pound.

9. At what rate per cent. per annum does £791 13*s.* 4*d.* bear £178 2*s.* 6*d.*, simple interest, in 5 years?

10. A sets out on a journey, and walks at the rate

of $3\frac{3}{4}$ miles an hour; B sets out, from the same place, on a bicycle, 1 hour and 52 minutes later, and follows him at the rate of $8\frac{1}{4}$ miles an hour. In what time will he overtake A?

11. A fruiterer having bought a number of pine-apples, sold one half of them at 18*d.* each, gaining thereby $33\frac{1}{3}$ per cent.: how much per cent. did he gain by selling the remainder at 15*d.*?

12. A bookseller buys 50 copies of a work at such a price, that if he can sell them at 4*s.* 10*d.* a copy, he will be a gainer of $8\frac{3}{4}$ per cent.; but he accepts an offer for the whole at once, at a profit of 5 per cent. What does he get per copy?

13. A wine merchant buys rum at a certain price per gallon, and dilutes it with water in such proportion, that he gains 16 per cent. by retailing the mixture at the same price. How much water is there in every gallon of the mixture?

14. If 3 men or 5 boys can be kept 4 months for £25, what sum will keep 5 men and 11 boys for 3 months, when the price of provisions is 16 per cent. higher than before?

15. What sum of money will amount to £3575 in 6 years, at 5 per cent. per annum simple interest?

16. If 2 pioneers along with 5 peasants can form an entrenchment in $3\frac{1}{2}$ hours, in what time could 7 pioneers along with 4 peasants form it, supposing that as much of the work can be done in an hour by 7 peasants as by 8 pioneers?

17. A bill of exchange for £34 12*s.*, payable 63 days hence, is cashed according to true discount,

the proceeds, calculated to the nearest penny, being £34 7*s.* 3*d.*: find the rate of interest.

18. If 3 men and 4 boys can reap 2½ acres in a day, and 5 men and 3 boys can reap 3¼ acres in a day, how long will it take 4 men and 6 boys to reap 21 acres?

No. 10.

1. Find, to the nearest penny, the amount by simple interest of £470 11*s.* 9*d.* in 7 months, at 5¼ per cent. per annum.

2. If £5 8*s.* 6*d.* be the cost of 9 yds. 2½ qrs. of cloth, how many pieces, each 24 yards, would 47 guineas and a crown purchase?

3. Find, in miles, furlongs, &c., the rate per hour of a train, which runs 21 mi. 2 fur. 23 po. 5 yds. in 38 min. 12 sec.

4. When the simple interest on £380, for 3 years 36 days, is £58, what is the corresponding interest on £475 for 2 years 50 days?

5. In what time will £435 produce £11 12*s.* simple interest, at 3½ per cent. per annum?

6. Find the true discount on £472 11*s.* 9*d.*, due 75 days hence, reckoning interest at 4½ per cent. per annum.

7. What is the worth of spirits per gallon, if adding 1 gallon of water for every 40 would make the diluted gallon worth 17*s.* 6*d.*?

8. Calculate by Practice—

(i) $234\frac{3}{8}$ cubic feet, at £2 14*s.* 8*d.* per cubic foot.

(ii) $870\frac{3}{4}$ square yards, at 12*s.* $9\frac{3}{4}$*d.* per square yard.

(iii) 23 tons $17\frac{1}{2}$ cwt., at £4 17*s.* 4*d.* per ton.

9. By selling an article for 5*s.* 2*d.* I gained $8\frac{1}{2}$ per cent. Find the prime cost.

10. The sum of £1240 being wanted to complete the cost of building a church, three gentlemen, A, B, C, agree to make up the sum, by subscriptions reciprocally proportional to the distances of their dwellings from the church. A lives 2 miles off, B $2\frac{1}{4}$ miles, C $3\frac{1}{2}$ miles. How much does each gentleman contribute?

11. A and B become partners in trade, A advancing £6000, and B £5000. Three years afterwards, A advances £3000 more, and B £4000 more; and at the end of eight years, from the establishment of the business, they sell it for £20500. How much of this should each partner receive?

12. Find the value of 35 bushels of potatoes, when 5 bushels of potatoes are worth 2 bushels of onions, 9 of onions worth 8 of pears, and 7 of pears worth 32*s.* 3*d.*

13. When an income tax of 6*d.* in the pound reduces a person's gross income to £256 15*s.* nett, what is his gross income?

14. If 7 men earn as much in a day as 10 women, and if 5 men and 4 women earn together 26*s.* in a day, how many men along with 7 women earn together 43*s.* in a day?

15. The rent of one farm, containing 280 ac. 3 ro. 15 per. is £786 7*s.* 3*d.*, that of another, containing 263 ac. 2 ro. 16 per., is £691 19*s.* Compare in simple terms the rents per acre.

16. If by selling silk at 3*s.* 9*d.* a yard a draper's profit would be $8\frac{3}{4}$ per cent., for what must he sell a dress-length of 18 yards, to gain $9\frac{5}{8}$ per cent.?

17. If selling an article for 19*s.* 3*d.* would be losing at the rate of 8*d.* on half-a-crown, what selling price would be a gaining at the rate of $3\frac{1}{2}$*d.* on a shilling?

18. If 20 men or 33 women can do a certain amount of farm work in 3 days of $8\frac{1}{3}$ hours long, how many men with the help of 11 women could do thrice the amount of work in $2\frac{1}{2}$ days of 9 hours long?

PART THIRD.

Higher Arithmetic.

No. 1.

1. Find the square root of $7\frac{3}{20} \times 7\frac{25}{28} \times 5\frac{12}{35}$; and of ·04355569.

2. Divide $4\frac{3}{13}$ of 2·1723 by $3\frac{1}{3}$ of $2\cdot\dot{5}1\dot{2}0\dot{9}$.

3. Find the cube root of 15 to three places of decimals.

If 15 cubic inches of metal be made into eight equal cubes, find the length of the edge of each cube, correct to the thousandth part of an inch.

4. Multiply, by duodecimals, 11 ft. 1 in. 6 pts. by 6 ft. 6 in. 8 pts., and the product by 11 ft. 8 in. Reduce the result to cubic yards, feet, and inches.

5. If tea bought at 3*s.* 4*d.* per lb. be sold at 3*s.*, what is the loss per cent.? And if 42 lb. of tea at 3*s.* 4*d.* be mixed with 112 lb. bought at 2*s.* 6*d.*, and the mixture be sold at 3*s.* per lb., what will be the gain per cent.?

6. Find the true, and also the mercantile, discount on £1516 11*s.* $5\frac{1}{2}$*d.*, due 1 year 219 days hence, interest $3\frac{3}{4}$ per cent. per annum.

7. Find the amount, by compound interest, of £346 15*s.* in 4 years, at $3\frac{1}{2}$ per cent. per annum.

8. Divide the number 1234 into three parts having the proportion of 6889, 7387, and 8051.

9. What is the price of $3\frac{1}{2}$ per cent. stock when a sum of £8567 16*s.* 3*d.*, invested without charge for brokerage, produces an income of £324 3*s.* 9*d.* per annum? If brokerage were charged $\frac{1}{8}$ per cent., how much less would the income be from the same investment?

10. A rough block of stone 72 feet long, and having an average transverse section of $56\frac{1}{2}$ square feet, loses one-third of its volume by being shaped, and then weighs 226 tons. Find the weight in lbs. of a cubic foot of it.

11. Supposing a cubic inch of iron to weigh $6\frac{1}{4}$ ounces, what will be the length of a round iron rod $\frac{1}{4}$ inch in diameter, which weighs 5 lb. 1 oz. 13 drs.?

[Circumference of a circle = 3·1416 × diameter.]

12. Transform 17400 from the denary to the duodenary scale of notation, and find the square of it in the duodenary scale.

13. A starts at midday to walk from London to Reading, a distance of 39 miles, at the rate of 4 miles an hour; B starts at 6 P.M. from Reading for London on a bicycle, going 16 miles an hour. At what hour will they meet? And how far will A be from Reading when B gets into London?

14. A trench 920 ft. long, 17 ft. wide, and 10 ft. deep has been dug by 7 men and 2 boys: the work could have been done in the same time by 6 men and 5 boys. What length of a trench 15 ft. wide

and 12 ft. deep could be dug by 5 men and 3 boys in half the time?

15. The half-yearly dividends on £18600 Three per Cent. stock are invested as they become due in the same fund in augmentation of the stock, at 96, 94½, and 93, respectively. By how much will the dividend for the fourth half-year exceed that for the first?

16. Divide 333 into two parts, such that the sum of 13 times the first part and 31 times the second shall be equal to 21 times the entire number.

No. 2.

1. What is the least number to be added to a million, that the sum may be exactly divisible by 365?

2. If an English sovereign is equal to 25·25 francs, or to 6⅔ thalers, find how many thalers there are in 16000 francs, and reduce the remainder to English money.

3. If $\cdot 85\dot{7}22\dot{7}$ of $3\cdot\dot{7}4\dot{0}$ of 11¼ cwt. of bread costs £31 11*s.* 3¾*d.*, what should be the price of a 2 lb. loaf?

4. If an income of £72 2*s.* be derived by investing £2034 5*s.* in 3½ per cent. stock, find the price of the stock.

5. If glass contains 76·2 per cent. of silica, 14·8 of potash, ·8 of lime, and 1 per cent. of alumina, find,

in lb. ounces and drachms, the weight of each in 2 cwt. of glass.

6. Find the true discount on £4611 5*s.* 8*d.*, due 7 months hence, at 4½ per cent. per annum.

7. Multiply, by duodecimals, 4 ft. 3 in. 7 pts. by 2 ft. 6 in. 3 pts., and the product by 8 ft. 9 in. What does the answer become when expressed in cubic feet cubic inches, and the fraction of a cubic inch?

8. The inside dimensions of a cistern are 8 ft. 3 in. long, 5 ft. 4 in. wide, and 4 ft. 10 in. deep; find, in feet and the nearest two-place decimal of a foot, the depth of a cubical cistern of the same capacity.

9. What sum will amount to £614 2*s.* 6*d.* in 3 years at 6¼ per cent. per annum, compound interest?

10. What principal, and at what rate per cent. per annum, simple interest, would amount to £56 13*s.* 10½*d.* in 2½ years, and to £58 6*s.* 3*d.* in 3⅓ years?

11. What is the nett income obtained from the investment of £1986 17*s.* 3*d.* in the 3 per cents. at 97⅞, after paying income tax at 5*d.* in the pound?

12. Find the price of 6 per cent. debentures, when £1200 invested in them will produce the same income as £1955 in the 3 per cents. at 97¾.

13. For what sum must goods worth £28800 be insured at a 3 per cent. insurance premium, in order that, in case of loss, the owner may recover both the value of the goods and the amount of premium paid?

14. The cost of papering the walls of a room 19·5

feet long, 17·25 wide, and 10 high, with paper 1·6 feet wide, is 27*s.* 6¾*d.*; what is the cost of the paper per piece of 12½ yards, not reckoning any deductions for door, windows, &c.?

15. If the Three per Cent. Consols are at 81⅞, what must be the price of the Five per Cents., that there may be no loss of income in selling out of the former and reinvesting in the latter, allowing for the usual brokerage of ⅛ per cent. of stock, on each transaction?

16. There are two single-volume editions of a work: one sells at 4*s.* 1½*d.*, the other at 2*s.* 7½*d.*; and I have ordered so many copies of each, that 3*s.* 6*d.* a volume will buy the lot. What is the smallest number of copies I can have ordered of each edition?

No. 3.

1. Find the square root of $\frac{6}{3}\frac{3}{6}\frac{3}{5}$ of $(7\frac{5}{9}+3\frac{4}{5})$.

2. In what time will £47 10*s.* yield £1 8*s.* 6*d.* simple interest, at 3¾ per cent. per annum?

3. Find the compound interest on £1260 for 5 years, at 4 per cent. per annum.

4. Divide £407 13*s.* into four parts, in proportion as 2⅔, 3¾, 4⅘, and 5⅚.

5. What sum of money improved at 2½ per cent. per annum, simple interest, for 7 months, together with an equal sum improved at 3¾ per cent. for the same period, would yield 3 guineas?

6. If 5 men or 7 youths can do a piece of work in $10\frac{1}{3}$ hours, in what time would 6 men and 4 youths together do it?

7. If £63 10*s.* was the nett amount of an invoice when $4\frac{3}{4}$ per cent. discount on the gross was allowed, what would have been the nett amount if only $4\frac{1}{2}$ per cent. had been deducted?

8. What principal would by simple interest amount to 14*s.* 6*d.* more in 4 years at $3\frac{1}{2}$ per cent., than in 3 years at $4\frac{1}{2}$ per cent.?

9. How many lb. of tobacco at 5*s.* $1\frac{1}{2}$*d.* per lb. must a tobacconist mix with 10 lb. at 5*s.* 3*d.*, to gain $16\frac{2}{3}$ per cent. by selling the mixture at 6*s.* 1*d.*?

10. If a vessel can be exactly filled with either 44 ounces of water or 597 ounces of mercury, how many cubic inches of mercury have the same weight as 100 cubic inches of water?

11. The principal £260 produces a certain sum of simple interest in a certain time, at a certain rate per cent. per annum; what principal would yield a sum of interest twice as large in $\frac{2}{3}$ of the time, at $\frac{4}{5}$ of the rate per cent.?

12. Reckoning the French mètre equal to 3·2809 English feet, find the nearest four-place decimal multiplier that will reduce yards to mètres.

13. Reduce the octonary number 42075 to its equivalent in septenary notation.

14. A person invested £3584 in 3 per cent. stock at 84, and, on the price rising to $85\frac{1}{8}$, he sold out, and invested the proceeds in $3\frac{1}{2}$ per cent. stock at 96; what alteration was thereby made in his income?

15. When yearly incomes of £150 and upwards are chargeable with 7*d.* in the pound income-tax, what chargeable income would be practically equivalent to an exempted income of £147 11*s.* 4*d.*?

16. How many lb. of tobacco at 4*s.* 6*d.* a lb., and how many at 5*s.* 3*d.*, will form together a mixture of 36 lb. worth 4*s.* 10*d.* a lb.?

No. 4.

1. How often can $72\frac{3}{8}$ be successively subtracted from $6090\frac{1}{4}$? and what would the final remainder be?

2. Calculate the true, and also the mercantile present worth of £350, payable 65 days hence, interest being at 3 per cent. per annum.

3. At what rate per cent. per annum, simple interest, will £1238 10*s.* amount to £1486 4*s.* in 4 years?

4. Find the amount of £600 by compound interest in 4 years, at $3\frac{3}{4}$ per cent. per annum.

5. If the value of $11\frac{5}{8}$ ounces be 13*s.* $2\frac{4}{7}$*d.*, what is the value of 10·65 ounces of the same article?

6. Express in decimal form the result of dividing $1{\cdot}2730\dot{8}5\dot{1}$ by $2{\cdot}35\dot{8}$.

7. An author is paid for a work by a bill at 3 months for £120. He gets the bill discounted (according to the mercantile method), when it has

80 days to run, at 5 per cent. per annum. Find the cash proceeds.

8. Simplify $\frac{4\frac{7}{12}-\frac{2}{3} \text{ of } 3{\cdot}08}{2\frac{5}{9}+\frac{8}{15}-\frac{7}{12}}$.

9. If by selling a watch for £5 6*s.* 8*d.* I should gain 12 per cent., at what price must I sell it to gain $15\frac{1}{2}$ per cent.?

10. When the compound interest on £500 for 3 years is £62 8*s.* 7·68*d.*, what is the rate per cent. per annum?

11. If by fair trade profit I ought to have $16\frac{2}{3}$ per cent. on an article which cost me 18*s.*, what would be the sacrifice per cent. if I sold it for 18*s.* 8*d.*?

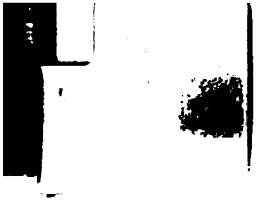
12. What principal would by simple interest amount to £330 16*s.* 9*d.* more in $7\frac{1}{2}$ years at $4\frac{1}{2}$ per cent. per annum, than in 5 years at $3\frac{1}{4}$ per cent. per annum?

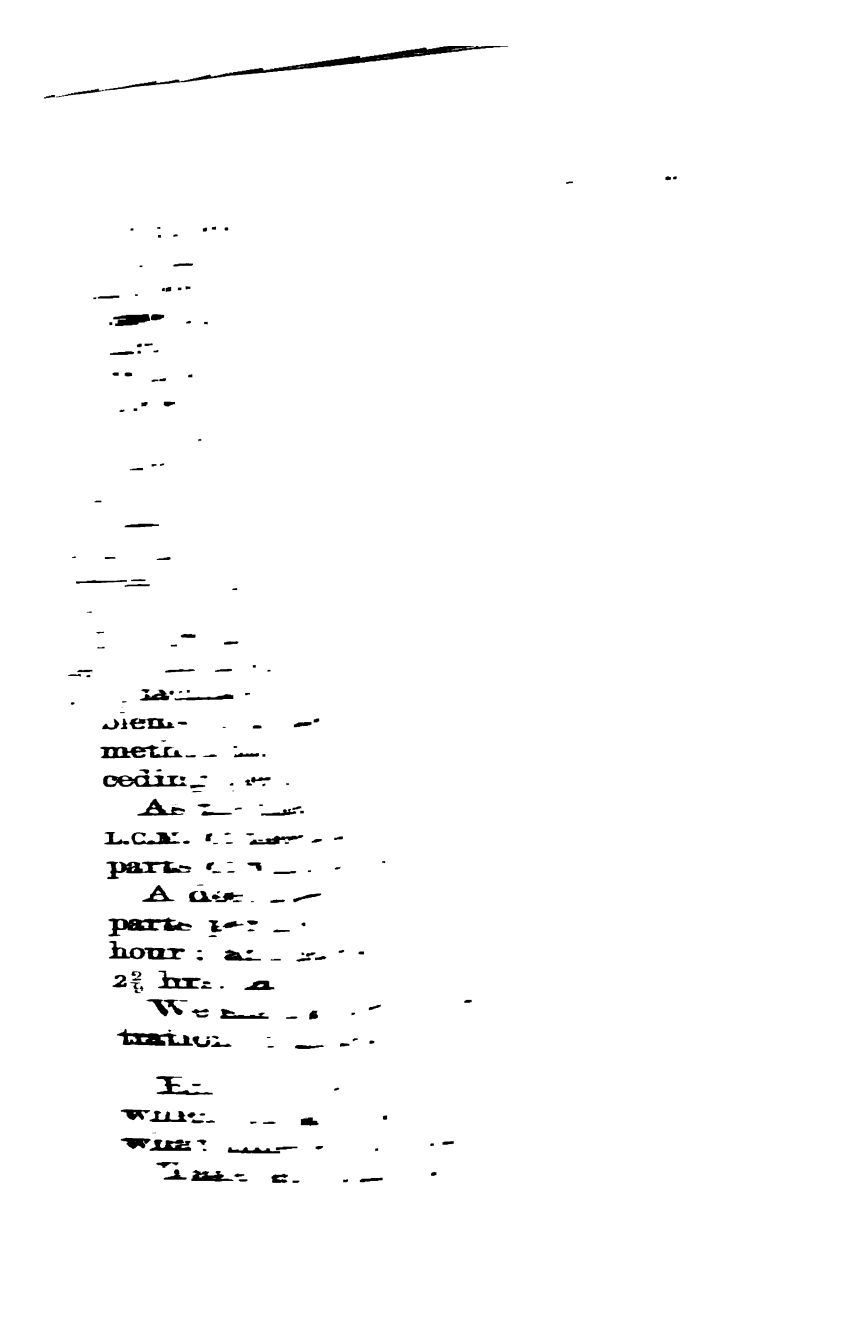
13. A person invested £1245 10*s.* in $3\frac{1}{2}$ per cent. stock, and afterwards sold out the stock at $83\frac{1}{2}$, and invested the proceeds in 4 per cent. stock at 94, whereby his income was made greater by 16*s.* 8*d.* At what price did he invest in the $3\frac{1}{2}$ per cents.?

14. What two quantities of tea, worth 2*s.* 10*d.* and 3*s.* 3*d.* a lb. respectively, must be mixed to make a package of 10 lb. worth 3*s.* a lb.?

15. Multiply together the duodenary numbers 58*t*3 and 6*e*47. [The symbols *t* and *e* are used for *ten* and *eleven*.]

How would the value of the result be expressed in the denary or common scale?





No. 6.

1. Find to the nearest fourth decimal the square root of ·07879.

2. If 6 oz. 7 dwt. 8·9 grs. of silver be worth 32*s.* 8*d.*, what is the value of 4 oz. 10 dwt. 23½ grs.?

3. A pound avoirdupois is 7000 troy grains:—Reduce an ounce avoirdupois to the decimal of an ounce troy.

4. Simplify (i) $\frac{4\frac{3}{5} \times 10\frac{4}{5}}{4\frac{3}{5} - 3\frac{1}{5}}$, (ii) $\frac{6\frac{3}{5} - 7\frac{1}{2}}{7\frac{1}{2}} + \frac{5}{7\frac{7}{8}}$.

5. In what time should £87 8*s.* yield £6 16*s.* 6¾*d.*, simple interest, at 2½ per cent. per annum?

6. What final remainder will there be, when ·1883 is successively subtracted as often as possible from 17·17?

7. What interest on money is implied by the Three per Cents. being at 87½?

8. A ship worth £10520 is so insured that, if lost, the owners may recover both the value of the vessel and the premium at 1⅜ per cent.; on what sum is insurance effected, and what is the amount of premium?

9. Find the compound interest on £246 13*s.* 4*d.*, at 3½ per cent. per annum, for 6 years.

10. If 12 equally expert women could do 55 yards of plain hand-sewing in 6½ hours, in what time could 9 of them do 76 yards of plain machine-sewing, supposing 117 yards to be done by the machine in the time that 5½ yards are done by hand?

11. What principal would amount to £2589 5*s.* 5¼*d.* in 2½ years, at 3 per cent. per annum, simple interest?

12. A silver salver weighing 32 ounces cost £13, the cost per ounce for the workmanship being equal to ⅔ of the cost of the metal. What was the price per ounce of the unwrought silver?

13. Of two iron balls, of the same density, one is six times as big as the other. If the diameter of the smaller be 100, what is the diameter of the larger?

14. A person invested £596 11*s.* in 4¼ per cent. stock at 87⅛, and when the price fell to 85 he sold out, and invested the proceeds in another description of stock at 97, whereby his income was augmented by 18*s.* What kind of stock did he now hold?

15. Having bought some wine at the rate of 99 shillings for 10 gallons, I merely recovered the outlay by selling part of it at the rate of 49 shillings for 5 gallons, and the remaining quantity at the rate of 71 shillings for 7 gallons. What were the two quantities, if the former was 100 gallons more than the latter?

16. Divide 12½ into two parts, so that 5 times one added to 8 times the other shall make 80.

No. 7.

1. What is the smallest sum of money that can be divided into an exact number of equal shares, each 2*s.* 4½*d.*, or 3*s.* 9*d.*, or 7*s.* 11*d.*?

2. Multiply 26·73 by ·02746.

3. There are two rectangular fields of equal area: one is a square field of which the side is 193 links; the other is 324 links in length: what is its breadth?

4. Find to six decimal places the cube root of ·0123.

5. Simplify $\dfrac{\frac{40}{51} - \frac{4}{9} \text{ of } \frac{25}{31}}{\left(\frac{50}{51} - \frac{4}{9}\right) \text{ of } 4\frac{38}{41}}$.

6. What is the prime cost of a yard of cloth, if retailing it at 6 per cent. profit would be 1*s.* 4*d.* better than at 4 per cent. loss?

7. A's home is 10 miles west from B's and B's is 24 miles north from C's; how far apart are the homes of A and C?

8. A can do $\frac{2}{3}$ of a piece of work in 56 minutes, B $\frac{4}{7}$ of it in 50 minutes; in what time would A and B together do $\frac{7}{8}$ of it?

9. Find the area of a triangular field of which the three sides measure 200, 409, and 551 links.

10. If a piece of Turkey stair-carpet 50 feet long, in being bought at 15*s.* 2*d.* per yard long, costs 19*s.* 6*d.* per square yard, what length of Brussels stair-carpet 26½ inches wide would cover an equal amount of space?

11. A sets out from M on a bicycle, and rides at the rate of 8½ miles an hour; after he has rode 56 minutes, B starts from M on horseback in the same direction at a uniform rate which enables him

to overtake A in 2 hours 16 minutes. Required B's speed per hour.

12. If cloth bought at the rate of £35 for 57 yards be sold at the rate of £16 for 25 yards, for what must 100 yards of cloth, bought at the rate of £7 for 16 yards, be sold to realise the same profit per cent.?

13. What quantities of tea, at 2*s.* 8*d.* and 3*s.* 4*d.* per lb. respectively, will when mixed make up a quarter of a cwt. worth 2*s.* 11*d.* per lb.?

14. What sum will produce £48 9*s.* 2·6*d.* compound interest, at 6 per cent. per annum, in 4 years?

15. At the beginning of the year a person lent £310 in two separate sums,—one at $3\frac{1}{8}$, and the other at $4\frac{3}{4}$ per cent. per annum; and he thus obtained at the end of the year $4\frac{1}{2}$ per cent. interest on the whole. What were the several sums lent?

16. To 21 lb. of tea at 2*s.* 10*d.* a lb. and 33 lb. at 3*s.* 3*d.*, I wish to add a quantity worth 3*s.* 9*d.* a lb., so that the mixture of the three kinds may be worth 3*s.* 6*d.* What quantity is to be added?

No. 8.

1. Find to six places of decimals the cube root of $\cdot\dot{7}\dot{0}$.

2. Find the amount, by compound interest, of £608 11*s.* 6*d.* at $5\frac{1}{4}$ per cent. per annum, for 3 years.

3. Find, in simplest terms, the vulgar fraction that is equal to the square root of

$$\frac{61 \text{ cwt. } 1 \text{ qr. } 17 \text{ lb.}}{158 \text{ cwt. } 3 \text{ qrs. } 17 \text{ lb.}}$$

4. The population of a village is 1095; ten years ago it was 1056; what will it be ten years hence, if it increases at as nearly as possible the same rate?

5. Simplify $\dfrac{14\frac{17}{20} - \frac{x^0}{21} \text{ of } \frac{3}{7} \text{ of } 1\frac{1}{4}}{\frac{6\frac{1}{12}}{2\frac{3}{4}} + \frac{\frac{3}{8}}{3\frac{2}{3}}}$.

6. If 900 tons of coal, bought at the rate of 53 tons for £50, are sold at the rate of 17 tons for £18, what is gained per cent.?

7. The sum of £191 13*s.* 4*d.* is to be divided among 17 men, 19 women, and 9 boys; each woman to receive half as much as each man, and each boy half as much as each woman. What will be each person's share?

8. At what time between 4 and 5 o'clock are the hour and minute hands of a watch at an angle of 150°?

9. A rectangular block of statuary marble cost £145, at the rate of 2 guineas per cubic foot; it was $6\frac{1}{2}$ feet long and $4\frac{1}{4}$ feet broad. What would the cost have been if the thickness had been $2\frac{1}{2}$ feet?

10. A can perform a certain amount of work in 10 days, B can do it in 14 days, C in 15 days; in what time could the three together do it?

11. What sum would amount to £6592, by compound interest at 7 per cent. per annum, in 5 years?

12. A person bought £1666 13*s.* 4*d.* of 3 per cent. stock, when the price was 87, and, on the price raising $\frac{1}{2}$ per cent., he sold out, and with the proceeds bought $4\frac{1}{4}$ per cent. stock at 119. What alteration was thus made in his income?

13. A fruiterer bought 350 apples, some at 3 a penny, and the rest at 5 a penny. How many must he have bought at each price, if he cleared 12 per cent. by selling them, one with another, at 2*s.* 8*d.* a hundred?

14. How much whisky at 17*s.* 6*d.* a gallon must be mixed with the like quantity of another kind at 17*s.*, and with $10\frac{1}{2}$ gallons of a third kind at 21*s.*, to form a blend of the three worth 19*s.* a gallon?

15. Reduce the septenary fractions $\frac{10}{12}$, $\frac{15}{22}$, and $\frac{333}{5110}$ to their lowest terms in the same scale of notation.

16. How much brandy at 22*s.* 6*d.* a gallon mixed with three-fourths as much at 19*s.* and with 28 gallons at 25*s.* 6*d.*, will make a mixture worth 23*s.* a gallon?

No. 9.

1. How long will it take to walk round a square field containing 21 acres 121 yards, at the rate of $3\frac{5}{8}$ miles an hour?

2. A bankrupt owed £1495, of which £245 was due to A, £305 to B, £270 to C, and the rest to D. On payment, D received as much as was due to C.

Find the amount of the bankrupt's estate, and how much it yielded in the pound.

3. Find the square root of 376·585 to four places of decimals.

4. Find the cube root of $13\frac{3}{343}$ to three places of decimals.

5. A piece of ground containing 3 roods 23 per. $6\frac{1}{4}$ sq. yds. is divided into four allotments, the *1st* being to the *2nd* as 4 : 3, the *2nd* to the *3rd* as 5 : 4, and the *3rd* to the *4th* as 6 : 5. Find the extent of each allotment in square yards.

6. If a piece of work can be finished in $22\frac{2}{3}$ hours by 7 men of ordinary expertness along with 5 of $\frac{1}{4}$ better and 2 of $\frac{1}{2}$ better than ordinary, in what time could the work be done by 3 men of ordinary expertness along with 6 of $1\frac{1}{3}$ ordinary and 8 of $\frac{3}{4}$ ordinary?

7. If A can do a piece of work in $7\frac{1}{2}$ hours, A and B together in $4\frac{1}{3}$ hours, and A and C together in 4 hours, in what time can B and C together do it?

8. Extract according to nonary notation the square root of the nonary number 28042827.

9. A stone pillar, in shape a cylinder of 3 feet diameter with the top rounded into a hemisphere, is found to weigh exactly twice as much as a sphere 6 feet in diameter made of the same sort of stone. What is the height of the pillar?

[Volume of a sphere = $\frac{2}{3}$ of that of its circumscribing cylinder.]

10. What is the present worth of £1721 5*s.* $8\frac{1}{4}$*d.*

due 4 years hence, reckoning compound interest at $3\frac{1}{2}$ per cent. per annum?

11. A cylindrical reservoir, whose diameter is 10 feet and depth $10\frac{1}{8}$ feet, is supplied by two pipes; one of them alone could fill it in 20 minutes, and water flows in through the other at the rate of 200 gallons a minute. If both the pipes are opened simultaneously, how long will they take to fill the reservoir, supposing the volume of 11 gallons of water to be 3050 cubic inches?

[Area of a circle = 3·1416 times the square of its radius.]

12. A person saw the flash of a gun fired from a frigate at sea, distant 1 mile 480 yds., and 4 seconds afterwards saw the flash of another gun fired from a vessel in a line between him and the frigate; and 2 seconds later still he heard the two reports simultaneously. Find the distance between the vessels.

13. A waterman found by experience that with the advantage of a common tide he could row down a river from A to B which is 18 miles, in $1\frac{1}{2}$ hours; and that to return from B to A, during the same tide, though he rowed back along the shore, where the stream was only three-fifths as strong as in the middle, took him $2\frac{1}{4}$ hours. Required the hourly velocity of the middle current.

14. What principal improved at $4\frac{1}{2}$ per cent. per annum, simple interest, for 6 years, will produce an amount of interest equal to the sum of the interests of £195 of it for 8 years at $2\frac{1}{2}$ per cent., and the rest for 4 years at $7\frac{1}{2}$ per cent.?

15. M and N were engaged together to do a

certain amount of work, which M alone could have done in 12 hours, and N alone in $13\frac{1}{3}$ hours. M continued till the work was finished; but N left off $2\frac{1}{2}$ hours before its completion. In what time was the whole work done?

16. What two equal quantities of whisky, worth 18*s.* 4*d.* and 19*s.* 6*d.* a gallon, respectively, will, if mixed with 6 gallons worth 17*s.* 8*d.* a gallon, make the mixture worth 18*s.* 3*d.* a gallon?

No. 10.

1. What vulgar fraction has 10 for its numerator, and ·345 for its nearest approximate value in thousandths?

2. A person invested £1107 in the 3 per cents. at 82. What was the amount of stock purchased? what income did it yield? and what rate of interest was obtained?

3. What principal would produce 16 shillings more by compound than by simple interest in 3 years, at 3 per cent. per annum?

4. If £2088 is to be divided among three persons A, B, C, so that B's share shall be 4 per cent. more than A's, and C's 5 per cent. more than B's, what will each receive?

5. One cubical cistern holds nine times as much as another: if the depth of the former be 25, what is the depth of the latter?

6. In navvy's work, A's ability is equal to the

joint ability of B and C. If A and B together could complete an excavation in $2\frac{1}{2}$ hours, and C by himself could do it in 8 hours, in what time could B alone do it?

7. If 92 French litre-bottles hold the same quantity as 81 imperial quarts, and a dozen imperial quarts hold as much as 17 reputed quarts, how much per cent. more than a reputed quart can the litre-bottle contain?

8. A boatman finds that to row $10\frac{1}{2}$ miles down a tidal stream from P and back again takes him 5 hours $3\frac{1}{3}$ minutes, and that to come 4 miles up takes him as long to go 9 miles down. What is his power of rowing in still water?

9. Simplify the fractions

$$\frac{\sqrt{2} \times \frac{1}{7}\sqrt{50}}{3\frac{1}{3} - \sqrt{1\frac{1}{7}\frac{2}{8}}} \text{ and } \frac{6 \text{ ft. } 5\frac{1}{2} \text{ in.}}{5 \text{ ft. } 6\frac{1}{2} \text{ in.}},$$

and then divide the first by the second.

10. I invested a certain sum in 3 per cent. stock at 72, and on the price rising to $74\frac{3}{8}$ I sold out; and then investing the proceeds in $3\frac{1}{4}$ per cent. stock at $79\frac{5}{8}$ I increased my income by £3 2*s.* 6*d.* What sum was originally invested?

11. What is the area of a sector of a circle, if its angle is $27\frac{1}{2}$ degrees, and its arc $7\frac{1}{2}$ inches?

12. Given two undenary numbers, 46018551 and *t*85 (where *t* is a symbol for *ten*); divide the former by the latter in their own scale.

13. I have just returned from an hour's uniform walk, having observed that at the outset the hands of my watch pointed in one direction, and that

when they came to point in exactly opposite directions, I had gone $1\frac{1}{2}$ mile. At what rate per minute did I walk?

14. A circle $10\frac{1}{2}$ inches in diameter being cut out of a larger concentric circle leaves a superficial ring measuring $5\frac{2}{3}$ square feet; what is the breadth of the ring?

15. Two sums of money, one of them £4 1*s.* 3*d.* more than the other, are lent at the same time for a year, the greater at $7\frac{1}{2}$ per cent., the less at 12 per cent.; and at the year's end the two loans are jointly repaid with £20 12*s.* $0\frac{1}{4}$*d.* What were the sums lent?

16. I bought 150 apples at the rate of 5 for 4*d.*, and 270 at the rate of 6 for 5*d.*; I also bought a third quantity, at the rate of 21 for 16*d.*; and I then observed that the average rate at which the whole had been bought was 14 for 11*d.* How many in all did I buy?

No. 11.

1. What rate per cent. of interest is got by investing in the $4\frac{1}{2}$ per cents. at 108?

2. Express approximately the value of ·37 by means of a vulgar fraction having 46 for its denominator.

3. A tank, 56 feet long and 16 feet wide, has supports capable of bearing safely a weight of 77 tons. What is the greatest depth of water that can be

safely allowed, if a cubic foot of water be supposed to weigh 1000 ounces?

4. C makes $12\frac{1}{2}$ per cent. by selling goods to D; what will D lose per cent. if he sell them for what they cost C?

5. Find to the nearest 6-place decimal the sum of 12 terms of the series $1 + \frac{1}{3} + \frac{1}{3^2} + \frac{1}{3^3} + \frac{1}{3^4} +$ &c.

6. Shew that the true discount on any sum is the present worth of the interest on that sum for the same time at the same rate.

7. A bookseller buys 50 copies of a book published at *2s. 6d.* He is allowed 30 per cent. on the publishing price, and 25 copies are charged to him as 24. What will he gain per cent. by selling the book at *2d.* in the shilling below publishing price?

8. Find the area, and the altitude also, of a triangle, its base being 77 yards, and the other sides 130 and 185 feet.

9. How much 3 per cent. stock must be sold out at $89\frac{1}{8}$, in order that the owner's income may be increased £12 by investing the proceeds in 4 per cent. stock at $91\frac{7}{8}$? The brokerage on each sale is $\frac{1}{8}$ per cent.

10. The mercantile discount on a certain sum, due 2 years 8 months hence, is £93 *2s.*, but the true discount is £81 *13s. 4d.* Find the rate of interest, and the sum.

11. Extract the square root of 105404·440241 in the scale of *six*, and transform the result to the duodenary scale.

12. A gentleman bequeaths half of his estate to his son, and one-third of it to three friends, A, B, C,

in shares as 3 : 2 : 1. He afterwards disposes of £500, and then divides the residue between B and C, in shares as 4 : 1. If C's portion comes to £6500, how much does each of the others receive?

13. Two boys, A and B, start together from the same point, and walk round and round a ring fence in opposite directions, till they meet exactly at the starting point; their last meeting place, before this, having been 990 yards from it. A's rate is to B's as 5 to 3. Find the distance covered by each.

14. If the price of barley be 48*s.* per quarter, and the cost of malting a bushel of barley be 4¼*d.*, how much malt is made from 1242 quarters of barley, when the maltster, after paying a tax of 3*s.* 1½*d.* per bushel of malt, makes 5 per cent. on his whole outlay by selling malt at 9*s.* 9*d.* per bushel?

15. I bought some pears at the rate of 15*d.* a dozen, and another quantity, greater by 12½ dozen, at the rate of 14*d.* a dozen. I then sold the whole of the pears, one with another, at the rate of half-a-guinea a hundred, and thereby gained 12 per cent. What two quantities did I buy?

16. A, B, and C perform a certain amount of work, the whole of which could be done by A alone in 18 days, by B alone in 22½ days, by C alone in 25 days. The work is begun by A and B together; but B is obliged to leave it 9 days before the time at which A has undertaken that it shall be finished. A therefore, at the end of 7 days engages C, with whose assistance the work is duly completed. What time does the whole work occupy?

No. 12.

1. What quantity of coffee costs 22*s.* 8½*d.* when there are just as many pounds bought as there are pence given for each pound?

2. If 174⅜ lb. be bought for £52 11*s.* 5*d.*, and 12 per cent. of the whole be allowed for waste, at how much per lb. must the remainder be sold, to gain 12½ per cent.?

3. A sold an article to B at a loss of 2*d.* per shilling of outlay; but B, selling it again to C at 3*s.* 9*d.*, gained 1½*d.* on his shilling of outlay. What did the article cost A?

4. Find the amount of £1600, by compound interest, in 5 years, at 5½ per cent. per annum.

5. What must be the market value of 5 per cent. stock that, after deducting the income tax of 5*d.* in the pound, it may yield 5⅜ per cent. interest?

6. A person sells out of the 3½ per cents. at 92¾, and realizes £18550; of which he invests ⅜ in the 4 per cents. at 96, and the remainder in the 3 per cents. at 90. Find the alteration in his income.

7. Shew that for a bicycle, with a wheel of 56 inches diameter, the number of revolutions in 10 seconds is almost exactly the rate in miles per hour.

[The circumference of a circle = 3·1416 × diameter].

8. The diagonal of a cube is $21\sqrt{3}$ feet; find the cost of painting its surface at 4*d.* a square yard.

9. Write according to senary notation the value

of the denary expression £89 16*s.* 6$\frac{3}{4}$*d.*; and then reduce to senary farthings.

10. Having given 24563 and 236 in the septenary scale, multiply them together; and transform the result to the duodecimal scale.

11. Two houses are built; twice as many workmen are employed about the second as about the first; the first is 16 months in building, and the second is 12 months; the wages of each of the first set of men are 4$\frac{1}{2}$*d.* an hour, and they work 9 hours a day; the wages of each man of the second set are 3$\frac{3}{4}$*d.* an hour, and they work 9$\frac{1}{2}$ hours a day. The building of the second house cost £760: what did the building of the first cost?

12. A could do a certain piece of work in 15 days; B could do it in 13$\frac{1}{2}$ days. Suppose they begin to do it together, but that B, continuing till it is finished, has been without A's help for the last 4 days; in how many days has the whole work been done?

13. The perimeter of a quadrantal sector of a circle is 40 inches: what is the area of the sector?

14. The present worth of a sum of money due 2 years 9 months hence is £56 13*s.* 4*d.*; but if payment were due 2 years 5 months later, the present worth would be £5 less. Find the rate per cent. and the sum.

15. A mass of lead ore weighed 7 tons; one portion of it yielded lead 78 per cent., and silver 8 ounces per ton; the remaining portion yielded lead 75 per cent., and silver 7$\frac{1}{2}$ ounces per ton. The total yield

of silver was 55 ounces. What average per cent. of lead did the whole mass contain?

16. Two equal quantities of spirits, one at 17*s.* 10*d.*, the other at 19*s.* 3*d.* a gallon, are mixed together, and to these are then added two other equal quantities at 18*s.* 4*d.* and 21*s.* 6*d.* respectively; and the whole forms a mixture of 66 gallons amounting to £64 7*s.* What were the quantities at the original prices?

No. 13.

1. Find the cube root of 7762392.

2. The numerator of a vulgar fraction is 23456: what is its denominator, if ·6789 + is the nearest 4-place decimal of the fraction?

3. To what fraction of 7 is $\frac{1}{4}$ of 9 reduced by a decrease of $37\frac{7}{9}$ per cent.?

4. A merchant sells cloth at 12*s.* 6*d.* a yard, and gains by the sale of 70 yards the prime cost of 3 yards. What would be his gain or loss per cent. if he sold the cloth at 12*s.* 3*d.* a yard?

5. A can do $\frac{4}{5}$ of a piece of work in 6 days, B can do $\frac{5}{6}$ of it in 7 days; if they work together, in what time will A have done $\frac{1}{20}$ more of the work than B?

6. Find in simple terms the square root of

$$\frac{5\frac{5}{8} + \frac{5}{12} \text{ of } 7\frac{7}{8}}{(4\frac{2}{5} + 2\frac{7}{9}) \times 25\frac{1}{2}}.$$

7. What quantity of tobacco at 3*s.* 8*d.* a lb. must be mixed with 45 lb. at 6*s.* a lb., so that the mixture may be worth 4*d.* an ounce?

8. To what sum would £8677 1*s.* 8*d.* amount in 3 years, by compound interest, if the rate were $4\frac{1}{8}$ per cent. per annum?

9. At what time between 8 and 9 o'clock do the hour and minute hands of a watch form an angle of 60°?

10. The square root of a certain number is 5379 by undenary notation. Find the value of the square number in the scale of 9.

11. Find to the nearest 4th place duodecimal the duodenary expression corresponding to 12·3456 in the scale of 8.

12. Suppose there are two cubical cisterns, one $3\frac{3}{8}$ times as capacious as the other, and that the width of the smaller is 7 ft. 4 in.: what depth of water can be contained by the larger?

13. A buys a stock of goods for £32 8*s.*, and sells them at a profit to B, who then sells them at the same rate of profit to C. If C in order to obtain the same rate of profit must receive £51 9*s.* for the goods, what has been the uniform gain per cent.?

14. Divide £8927 6*s.* 8*d.* into two parts, so that the simple interest on the greater shall equal the compound interest on the less in 3 years, at 4 per cent. per annum.

15. Divide the number 1248 into two parts, so that $\frac{7}{8}$ of one and $\frac{3}{4}$ of the other may together amount to 1000.

No. 14.

[*Set, under direction of the Civil Service Commissioners at an open competition for Men Clerkships of the Lower Division, in August*, 1882.]

1. Find the value, in £ *s.* *d.*, of

$3\frac{5}{17}$ of £49 4*s.* $11\frac{1}{2}$*d.* $- 1\frac{1}{8}$ of $\frac{22}{35}$ of £91 1*s.* 3*d.*

Reduce the result to the decimal of £1000.

2. Find (by Practice) the value of 129 acres, at £34 13*s.* 4*d.* per acre.

If a plot measuring 3 roods 31 poles $15\frac{1}{8}$ yards were taken off, by how much would the value be reduced?

3. Find the square root of

(1) 49·182169, (2) $3\frac{118}{169}$, (3) $8{\cdot}02\dot{7}$,

and the cube root of ·002048383.

4. The rent of an orchard is paid by selling the apples at 12*s.* for a bushel and a-half when the no. of apples produced is 8442; at what price per quart must the apples be sold to pay the rent when the no. produced is 7236?

5. Find by duodecimals the number of cubic feet and inches in a tank 10 ft. 8 in. long, 9 ft. 4 in. wide, and 8 ft. 9 in. deep.

How many tons of water will the tank hold if a cubic foot of water weighs 1000 oz.?

6. Find the number in the scale of 12 which is equal to 22161 in the scale of 10; divide 55974 by 67 in the scale of 11; and square 123 in the scale of 4.

7. At what rate per cent. per annum will the

simple interest on £920 2*s.* 1*d.* amount to £71 9*s.* $3\frac{3}{4}$*d.* in 2 years 3 weeks 5 days? (1 year = 365 days.)

8. A tradesman marks his goods at a price which will give him 25 per cent. profit; and he takes off $12\frac{1}{2}$ per cent. from the marked price for ready money. If an article marked 5 guineas is sold at the reduced price, find (1) what he gets for it, (2) what he gave for it, and (3) what rate per cent. profit on his outlay he still makes.

9. Find the cost of £9462 10*s.* stock in the 3 per cents. at $93\frac{3}{4}$ (inclusive of all charges), and the income which it produces.

A sells some stock, and B buys it, each paying the broker $\frac{1}{8}$ per cent. If the broker makes £8 8*s.* 3*d.* by the transactions, what is the amount of stock dealt with?

10. Find the difference between the simple and the compound interest of £6400 in 3 years, at $3\frac{3}{4}$ per cent.

11. The death-rate in a town is 16·25 per 1000 of the population for a half-year of 26 weeks, and 803 persons die in a year of 365 days: what is the population?

12. If 2 men do as much as 5 children, and 3 children do as much as 2 women, in what time will 6 men do what 3 women working 5 hours and 5 children working 3 hours have together accomplished?

13. The area of the floors of two rooms is the same, but the volume of one of them exceeds that of the other by 1080 cubic feet. If the length and height of the larger room are 24 ft. and 15 ft. re-

spectively, and the width and height of the smaller room are 18 ft. and 12 ft., what is the width of the larger, and the length of the smaller room?

14. A circle of grass 98 feet in diameter has a path of uniform width round it on the outside, the area of which is $3394\frac{2}{7}$ square feet: what is the width of the path, supposing the ratio of circumference to diameter to be 22:7?

No. 15.

[*Set, under direction of the Civil Service Commissioners, at an open competition for Men Clerkships of the Lower Division, in February*, 1883.]

1. Reduce to a single fraction—

$$\frac{919\frac{2}{7}}{7\cdot9\dot{5}\dot{4}} \times \frac{4\cdot\dot{1}0\dot{0}}{442\frac{30}{37}} \times \frac{7}{11} \text{ of } \cdot07344.$$

2. If 17 cwt. of lead cost £15 17*s.* 4*d.*, what is the value of 2 tons 15 cwt. 3 qrs. 15 lb.?

3. If a person spends £50 more than $\frac{19}{20}$ of a fixed income in a certain year, £35 less than $\frac{14}{15}$ of it in the next year, and $\frac{11}{12}$ of it in the year after that, and his savings in the three years amount to £705, what is his income?

4. Find the square root of 930·677049, and the cube root of $1458640\frac{1}{27}$.

5. Find by duodecimals the capacity of a rectangular tank which is 32 ft. long, 18 ft. 8 in. wide, and 8 ft. 4 in. deep. What will be the depth of water in the tank when the weight of the water is 56 tons 5 cwt., supposing a cubic foot of water to weigh 1000 oz.?

6. Divide 418·9666 by 6·289 in the duodenary scale of notation; reduce 296·7 from the duodenary to the denary scale; and find the value in decimals of ·1$\dot{5}$ in the scale of 7.

7. If the simple interest on £923 18*s.* 1½*d.* amounts to £17 9*s.* 3¾*d.* exactly in 138 days, what is the rate of interest per cent. per annum?

8. If a sum of £2320 10*s.*, due a year hence, is to be paid off at once, and .5 per cent. discount to be allowed, what difference will it make in the present payment if 5 per cent. of the whole amount is deducted, instead of the true discount?

9. The accounts of a company show that when 54 per cent. of the receipts have been used for working expenses, 10 per cent. set aside for a reserve fund, and a preference dividend paid on £250000 of the capital at 6 per cent., there will remain £30000; and this will be just sufficient for a dividend of 2½ per cent. on the rest of the capital. Find the capital and the receipts.

10. Two persons set out to walk from A to B: the first walks 4 miles an hour, and in 45 minutes he is ⅜ of a mile before the other; he then stops half an hour, afterwards proceeds at the same rate as before, and in the end arrives half an hour before the other, who has walked at a uniform pace all the way without stopping. What is the distance from A to B?

11. A grocer sells 56 lb. of tea at 4*s.* 6*d.* per lb., 112 lb. at 3*s.* 4*d.* per lb., and 166 lb. at 2*s.* per lb.; by the first he gains 40 per cent. of the cost, by the second 25 per cent., and by the third 50 per cent. Find his whole outlay, and his gain per cent.

12. A yard rule, made of metal, expands in hot weather so as to be ·05 of an inch too long, and contracts in cold weather so as to be ·02 of an inch too short. What is the true length of a line, the measures of which taken in hot and cold weather by this rule differ by $3\frac{1}{2}$ inches?

13. A person possessed of £1500 three per cent. consols sells out at 93; he invests half of the proceeds in six per cent. foreign securities at $116\frac{1}{4}$, £200 in a mortgage at $4\frac{1}{2}$ per cent., and loses the rest. Compare his first and final incomes.

14. If 12 men, 10 women, and 22 children, working together, earn £16 13*s.* in a week, and one woman earns as much as three children, and a man and a child as much as three women, what are the daily wages of each man, woman, and child?

15. The cost of levelling a square exercise ground is £70; and if each side were 3 feet longer the cost would be increased by £7 3*s.* 6*d.* What is the length of the side of the square, and the cost per square yard?

ANSWERS TO EXAMINATION PAPERS.

PART FIRST.

Vulgar and Decimal Fractions, &c.

No. 1.

1. $10\frac{8}{21}$.
2. $4\frac{89}{189}$.
3. $10\frac{1}{6}$.
4. $\frac{30}{49}$.
5. 84·7357.
6. 125·919707.
7. 53·45743176.
8. ·0023775.
9. 3489·672.
10. £3486 10*s*.
11. 7 ac. 3 ro. 23 po. 19 yds. 7 ft. 72 in.
12. £574 17*s*. 6*d*.
13. $14\frac{7}{48}$.
14. $\frac{109}{112}$.
15. 12.
16. $2\frac{2}{5}$.
17. 24942·6 grs.
18. 3·1146 pts.
19. ·042101457̇02̇.
20. 256.
21. $1649\frac{1}{181}$.
22. $10\frac{17}{36}$ oz.
23. 5 m.
24. $2\frac{1}{2}$ yrs.
25. £1075 16*s*. 8*d*.
26. ·87 of an inch.

No. 2.

1. $26\frac{25}{36}$.
2. $10\frac{11}{12}$.
3. $669\frac{2}{3}$.
4. $11\frac{5}{273}$.
5. 38·653.
6. 3·059897.
7. 86·205042.
8. 87·5.
9. 29694·0696.
10. 47*s*. $0\frac{1}{5}d$.
11. 25 ac. 1 ro. 14 po.
12. £245 4*s*. $4\frac{1}{2}d$.
13. $13\frac{8}{225}$.
14. $\frac{229}{285}$.
15. 8.
16. $\frac{88}{145}$.
17. 11700·0675 sq. ft.
18. 31·05548 hf. crs.
19. ·050607004.
20. 1620.
21. ·00027252.
22. £26 8*s*.
23. 25 m.
24. $11\frac{1}{4}$ hrs.
25. $£3\frac{3}{4}$.
26. 1 inch *nearly*

No. 3.

1. $8\frac{31}{36}$.
2. $8\frac{223}{224}$.
3. $1\frac{1}{8}$.
4. $\frac{25}{184}$.
5. 236·0825.
6. 4·09795.
7. 2293·940604.
8. 640.
9. 118·1775 fl.
10. £7 2*s*. $4\frac{29}{72}d$.
11. 2 ac. 3 ro. 11 po. 7 ft. 19 in.
12. £264 6*s*. $7\frac{3}{4}d$.
13. $17\frac{17}{140}$.
14. $\frac{263}{264}$.
15. $15\frac{1}{6}$.
16. $\frac{6}{215}$.
17. 2363·0532 yds.
18. 3737·3094 sq. yds.
19. ·6069 − ; ·0849 +.
20. ·00407 +.
21. $\frac{777}{820}$.
22. 5 months.
23. $\frac{3}{4}$.
24. $7\frac{1}{2}$ days.
25. 7*s*. $10\frac{1}{2}d$.
26. 5·08 in.

No. 4.

1. $30\frac{47}{72}$.
2. $25\frac{31}{35}$.
3. 9·56.
4. ·0005.
5. ·26749 − ; ·00597 +.
6. $872\frac{1}{2}$ galls. *nearly*.
7. ·092608 −.
8. 1007 + links.
9. 110·3082 hf. crs.
10. 10*s*. 6*d*.
11. $\frac{3441}{4015}$.
12. $\frac{9}{17}$; $385\frac{7}{25}$.
13. 1 ac. 3 ro. 19 po. 30 yds. 1 ft. 34 in.
14. 21*s*. 7·473 − *d*.
15. 15 times; rem. ·10004.
16. ·109 −.
17. 4 sixp.

No. 5.

1. $25\frac{26}{27}$.
2. $90\frac{22}{99}$.
3. $1\frac{103}{142}$.
4. ·01085.
5. $3\frac{81}{265}$, or $3\cdot\dot{3}1274\dot{1}$.
6. $\frac{1217}{3640}$.
7. 7·224 − oz.
8. ·0457638.
9. The latter.
10. $\frac{209}{312}$.
11. 960·0023 − sq. in.
12. 205·60044 + lb.
13. 2 m. 7 fur. 37 po. 3 yds. 2 ft. 7 in.
14. $5\frac{211}{265}$, or nearly $5\frac{4}{5}$.
15. £63 15*s*.
16. $\frac{48}{101}$ hr.
17. £10 16*s*.

No. 6.

1. $26\frac{1}{2}$.
2. $23\frac{249}{686}$.
3. $\frac{15}{169}$.
4. 275.
5. $1\frac{191}{271}$.
6. 1.
7. 1716·8833 +.
8. ·48046875.
9. The former.
10. $\frac{235}{468}$.
11. 7·66018 +.
12. 28961·4872 c. in.
13. 1 ro. 37 po. 28 yds. 5 ft. 15 in.
14. ·07672 −.
15. 18*s.* $11\frac{19}{28}$*d.*
16. $56\frac{98}{107}$.
17. 3696, 1980, and $1039\frac{1}{2}$ sq. yds.

No. 7.

1. $9\frac{11}{12}$.
2. $8\frac{515}{522}$.
3. ·00072.
4. 42·5.
5. $\frac{14}{27}$, or $\cdot\dot{5}1\dot{8}$.
6. $\frac{173}{105}$.
7. 2216·3648 oz.
8. $\cdot78\dot{3}$.
9. ·37736 −; ·00274 −.
10. $\frac{1}{33}$.
11. $\frac{53}{16000}$.
12. 6·438445 oz.
13. 18 sq. po. 29 yds. 1 ft. 130 in.
14. 2·9340625 yds.
15. 500 nav.
16. 6 days.
17. A £840, B £630, C £560.

No. 8.

1. 16.
2. $10\frac{13}{40}$.
3. $\frac{57}{828}$.
4. ·45905.
5. $45\frac{45}{101}$, or $45\cdot\dot{4}4\dot{5}5\dot{}$.
6. $5\frac{1}{4}$.
7. 86·520 − guin.
8. ·871$\frac{55}{2}$ + ac.
9. ·13$\frac{25}{2}\dot{7}$; ·0$\dot{2}\dot{7}$.
10. $\frac{295}{672}$.
11. ·86275.
12. 13·1303 − *s.*
13. 3 m. 3 fur. 17 po. 2 yds. 2 ft. 8 in.
14. ·00591 +.
15. 2 cwt. 3 qrs. 13·2272 lb.
16. $8\frac{1}{3}$ hrs.
17. £64, £48, £40.

No. 9.

1. $6\frac{19}{24}$.
2. $5\frac{8}{15}$.
3. $\frac{19}{19}$.
4. ·00217+.
5. $807\frac{3}{11}$.
6. $2\frac{9}{10}$.
7. 7·72983 − years.
8. ·009914 +.
9. ·0047 +; 3·3083 +.
10. 89.
11. 1·10184 −.
12. 2 ac. 1 ro. $28\frac{1}{2}$ per.
13. 2 ac. 1 ro. 17 po. 23 yds. 6 ft. 23 in.
14. 3*s*. $3\frac{1}{16}$*d*.
15. $745\frac{5}{7}$ yds.
16. $8\frac{7}{17}$ days.
17. 8·1, 9, 6·48, 12·15.

No. 10.

1. $90\frac{1}{9}$.
2. $9\frac{37}{42}$.
3. $6\frac{102}{103}$.
4. ·980104 −.
5. 33·6.
6. $8\frac{36}{55}$.
7. $7\frac{1}{2}$ c. ft.
8. ·120536 − tons.
9. ·29297 −; ·33042 − .
10. $\frac{1}{10}$.
11. $\frac{39}{115}$.
12. 138·249 p.
13. 2 ac. 1 ro. 15 po.
14. 7 cwt. 3 qrs. 13·85 lb.
15. $\frac{3}{25}$ less.
16. A 5 hrs., B $6\frac{1}{4}$ hrs., C $8\frac{1}{3}$ hrs.
17. 480, 560, 720 yds.

PART SECOND.

Proportion, Practice, &c.

No. 1.

1. 133 sq. yds. $6\frac{1}{3}$ ft.
2. $8\frac{1}{2}$ men.
3. £2 17*s*. $2\frac{2}{5}$*d*.
4. 16 gall. 3 qts. 1 pt.
5. £5 18*s*. 5*d*.
6. 5 oz. 13 dwt.+.
7. £163 16*s*.
8. £259 9*s*. $4\frac{1}{2}$*d*., £1139 0*s*. 9*d*., £131 15*s*. $1\frac{1}{4}$*d*.
9. 20*s*. 9*d*.
10. 20 p. c.
11. 30 p. c.
12. $3\frac{1}{4}$ p. c. *very nearly*.
13. 20*s*. 7*d*.
14. £245 10*s*.
15. £17 13*s*. 6*d*.
16. 78*s*. $1\frac{1}{2}$*d*.
17. 168 : 169.
18. £44 8*s*. $10\frac{2}{3}$*d*.

No. 2.

1. 6*s.* 4*d.*
2. $6\frac{3}{4}$ days.
3. 1 lb. 15 oz.
4. 63*s.* $8\frac{1}{2}\frac{3}{2}d.$, 84*s.* $11\frac{5}{11}d.$
5. 2 galls.
6. £740 19*s.* $8\frac{1}{4}d.$
7. £5 6*s.* $5\frac{1}{2}d.$
8. £334 19*s.* $11\frac{1}{4}d.$; £1843 5*s.* 0*d.*; £40 6*s.* $8\frac{1}{8}d.$
9. £237 12*s.*
10. £53 6*s.* 8*d.*
11. 3*s.* 7*d.*
12. 17*s.* 6*d.*
13. $1\frac{1}{14}$ p. c. gain.
14. $1\frac{1}{2}$ p. c. gain.
15. 1 ro. 3 per. $19\frac{1}{4}$ yds.
16. $11\frac{2}{3}$ days.
17. 288 : 247.
18. £861 15*s.* 5*d.*

No. 3.

1. 10 yds. 2 ft. 7 in.
2. 15800 c. ft.
3. 8*s.* $7\frac{1}{2}\frac{9}{0}d.$, or 8*s.* 8*d.*−
4. £73 10*s.* $4\frac{3}{7}\frac{5}{3}\frac{6}{0}\frac{9}{0}d.$, or £73 10*s.* $4\frac{1}{2}d.$ −
5. £350.
6. 48 galls.
7. £20 16*s.*, £22 16*s.*, £27 12*s.*, £28 16*s.*
8. £210 19*s.* $3\frac{1}{2}d.$; £1020 15*s.* 2*d.*; £28 9*s.* $6\frac{1}{3}d.$
9. £1012 10*s.*
10. $21\frac{3}{7}$ p. c.
11. 3*s.* 10*d.*; $11\frac{9}{3}\frac{9}{9}\frac{1}{1}$ p. c., or $11\frac{1}{4}$ p. c.+.
12. £7 0*s.* $7\frac{1}{2}d.$
13. 14*s.* $9\frac{7}{9}d.$
14. £452 12*s.*
15. 19 days.
16. Sheep, 45*s.*, bullock, £20 15*s.*
17. 14 : 15, or $\frac{14}{15}$.
18. £325 16*s.*

No. 4.

1. £8 4*s.* $4\frac{1}{2}d.$
2. $10\frac{1}{2}d.$
3. $8\frac{1}{4}d.$
4. 34*s.* 3*d.*; £7 0*s.* 9*d.*
5. $1\frac{3}{4}$ days.
6. 6 cwt. $4\frac{1}{2}$ lbs.
7. £477 18*s.* $3\frac{3}{2}\frac{3}{3}d.$
8. £99, £1102 8*s.* $6\frac{1}{2}d.$, £98 12*s.* $11\frac{5}{8}d.$
9. £27 18*s.*
10. £18 17*s.* $1\frac{5}{7}d.$
11. £3 8*s.* $6\frac{6}{7}d.$
12. 21 lb. sugar.
13. £26 16*s.* 3*d.*
14. £1026 8*s.* 9*d.*
15. 14*s.* 3*d.*
16. $1\frac{1}{1}\frac{1}{9}$ p. c. gain.
17. 27 : 46.
18. £76 0*s.* 10*d.*

No. 5.

1. 7*s.* 11*d.*
2. $16\frac{1}{35}$ days.
3. $6\frac{3}{4}$ cwt.
4. 270, 729.
5. 36 days.
6. $2\frac{3}{4}$ yrs.
7. 4*d.* in the pound.
8. £753 19*s.* 2*d.*,
   £243 7*s.* $3\frac{1}{2}$*d.*,
   £26 0*s.* $5\frac{1}{3}$*d.*
9. £59 3*s.* $9\frac{15}{37}$*d.*
10. £6 9*s.*
11. 237 frs.
12. $3\frac{1}{2}$ yrs.
13. £479 13*s.* 9*d.*
14. 27 gall.
15. 1680 men.
16. $6\frac{3}{7}$ hrs.
17. 6*s.* 8*d.*
18. $3\frac{1}{2}$ p. c. gain.

No. 6.

1. £11 17*s.* 3*d.*
2. 6 oz. 12 dwt.
3. $1\frac{1}{4}$ p. c.
4. £28 6*s.* 8*d.*
5. 135 days.
6. $15\frac{4}{5}$ p. c.
7. £223$\frac{1}{8}$, £351, £436$\frac{4}{8}$.
8. £273 2*s.* $6\frac{1}{10}$*d.*,
   £983 19*s.* $7\frac{1}{2}$*d.*,
   £37 9*s.* $11\frac{1}{4}$*d.*
9. $\frac{1}{2}$.
10. $8\frac{1}{10}$ hrs.
11. 210 men.
12. £320 12*s.* 6*d.*
13. $8\frac{3}{4}$ p. c.
14. 3*s.* $1\frac{1}{2}$*d.*
15. £465.
16. £1355 10*s.* 5*d.*
17. $14\frac{22}{27}$.
18. 10 : 15 : 18.

No. 7.

1. 74 gall. 3 qts. $1\frac{1}{16}$ pt.
2. 7*s.* 4*d.*
3. 22 miles an hour.
4. $4\frac{1}{8}$ p. c. per annum.
5. $1\frac{1}{2}$ galls.
6. £1450.
7. $3\frac{3}{8}$.
8. 1923 cwt. 12 lb.;
   £1785 17*s.* 6*d.*,
   £37 11*s.* $4\frac{1}{8}$*d.*
9. $3\frac{1}{2}$ p. c.
10. £520, £320, £320, £120, £120.
11. 3*s.* 5*d.*
12. 3*s.* $2\frac{3}{21}$*d.*
13. $11\frac{1}{4}$*d.*
14. £23 12*s.*
15. 55 : 54.
16. £98 13*s.* 4*d.*
17. $\frac{4}{7}$ p. c.
18. 30.

No. 8.

1. £437 10*s.*
2. 623 sovs.
3. 20 p. c.
4. $4\frac{4}{5}$.
5. £17 10*s.* $10\frac{10}{19}d.$
6. A 1 t. 8 cwt. 64 lb.; B 1 t. 12 ct. 16 lb., &c.
7. 14 p. c.
8. 2557 ac. 30 po.; £5792 9*s.* 6*d.*, £53 10*s.* $5\frac{1}{5}$.
9. 1250.
10. 65 lb.
11. $3\frac{3}{5}$ qts.
12. 301 *very nearly.*
13. £1300, £700.
14. $\frac{3}{4}$ of a year.
15. 6*d.*
16. 8 of each.
17. $\frac{4}{5}$ p. c.
18. £30.

No. 9.

1. £3061 10*s.*
2. $7\frac{3}{4}$ bu.
3. £159$\frac{9}{29}$, £154$\frac{4}{29}$, £96$\frac{16}{29}$.
4. 16 years.
5. $6\frac{2}{3}$ p. c.
6. 6 more men.
7. £3 3*s.* $2\frac{82}{221}d.$
8. £849 18*s.* 4*d.*, £474 5*s.* 5*d.*, £134 4*s.* $7\frac{9}{16}d.$
9. $4\frac{1}{2}$.
10. 1 hr. $33\frac{1}{3}$ min.
11. $11\frac{1}{9}$ p. c.
12. 4*s.* 8*d.*
13. $\frac{4}{29}$ gall.
14. £84 2*s.*
15. £2750.
16. $2\frac{1}{3}$ hrs.
17. 4 p. c.
18. 6 days.

No. 10.

1. £485 *nearly.*
2. $3\frac{2}{3}$ pieces.
3. 33 m. 3 fur. 38 po. 1 yd.
4. £50.
5. 10 months.
6. £4 3*s.* 5*d.*
7. 17*s.* $11\frac{1}{2}d.$
8. £641 4*s.* $9\frac{3}{5}d.$, £557 16*s.* $5\frac{13}{16}d.$, £116 3*s.* 10*d.*
9. 4*s.* $9\frac{1}{7}d.$
10. £504, £448, £288.
11. £10500, £10000.
12. 57*s.* 4*d.*
13. £263 6*s.* 8*d.*
14. 8 men.
15. 16 : 15.
16. £3 8*s.*
17. 33*s.* $10\frac{7}{8}d.$
18. 60 men.

PART THIRD.

Higher Arithmetic.

No. 1.

1. $17\frac{61}{140}$, 2087.
2. 109755.
3. 2·466 +; 1·233 +.
4. 31 c. yds. 13 c. ft. 10′ 3″ 4‴ = 31 c. yds. 13 ft. 1480 in.
5. Loss 10 p. c., Gain 10 p. c.
6. £85 16*s.* $10\frac{1}{2}$*d.*, £90 19*s.* 10·65*d.*
7. £397 18*s.* 0·86*d.*
8. $380\frac{202}{260}$, $408\frac{74}{260}$, $444\frac{262}{260}$.
9. $92\frac{1}{2}$; 8*s.* 9*d.* less.
10. $186\frac{2}{3}$ lb.
11. 22 ft. $2\frac{2}{3}$ in.
12. *toto* duod., 85488400 duod.
13. $\frac{1}{4}$ to 7 p.m.; $5\frac{1}{4}$ miles.
14. 340 ft.
15. £13 10*s.*
16. 185, 148.

No. 2.

1. 100.
2. 2·4224 thal.; 1*s.* 3*d.* +.
3. $3\frac{3}{4}$*d.*
4. $98\frac{3}{4}$.

lb.	oz.	drs.	
5. 170	11	0	+ sil.
33	2	7	− pot.
17	14	$11\frac{1}{2}$	+ li.
2	3	$13\frac{1}{2}$	− al.

6. £117 19*s.*
7. 94 c. ft. 9′ 9′ $5\frac{9}{16}$″; 94 c. ft. 1409 $\frac{9}{16}$ in.
8. 5·97 − ft.
9. £512.
10. £51 16*s.* 8*d.*; $3\frac{3}{4}$ p. c.
11. £59 12*s.* $7\frac{1}{2}$*d.*
12. 120.
13. £29690 14*s.* 6*d.* −.
14. 2*s.* 3*d.*
15. $136\frac{1}{8}$.
16. 7 dearer, 6 cheaper.

No. 3.

1. $1\frac{3}{5}$.
2. 292 days.
3. £272 19*s.* 7·84*d.*
4. £63 15*s.* $1\frac{9}{11}$*d.*
   89 13*s.* $2\frac{2}{11}$*d.*
   114 15*s.* $3\frac{3}{11}$*d.*
   139 9*s.* $4\frac{8}{11}$*d.*
5. £86 8*s.*
6. $5\frac{5}{6}$ hrs.
7. £63 13*s.* 4*d.*
8. £145.
9. 4 lb.
10. ·7·37 + c. in.
11. £975.
12. ·9144 −.
13. 101634 sept.
14. Increase 88*s.* 4*d.*
15. £152.
16. 20 lb., 16 lb.

No. 4.

1. 84 times; rem. $10\frac{3}{4}$.
2. £348 2*s.* 9.62*d.* − ;
   £348 2*s.* 7·23*d.* +.
3. 5 p. c.
4. £695 3*s.* 9·66*d.* −.
5. 11*s.* $10\frac{5}{7}$*d.*
6. ·5396.
7. £118 13*s.* 8*d.* +.
8. $1\frac{2}{205}$.
9. £5 10*s.*
10. 4 p. c.
11. $11\frac{1}{9}$ p. c.
12. £1890 10*s.*
13. $79\frac{1}{2}$.
14. 6 lb. and 4 lb.
15. 33*t*5236 duoden ;
    119049405 den.
16. $4\frac{1}{2}$ and $7\frac{1}{2}$ qts.

No. 5.

1. $\frac{6}{7}$.
2. 1·609 −.
3. $80\frac{3}{5}$ nav.
4. $4\frac{1}{8}$.
5. 94.
6. 10*s.* 9*d.*
7. 90 p. c.
8. App. $8\frac{1}{2}$*d.*, Pea. $10\frac{1}{2}$*d.*,
   Or. $11\frac{1}{2}$*d.*
9. $10\frac{3}{5}$ p. c.
10. $2\frac{6}{7}\frac{6}{8}$ bu.
11. £176 12*s.* 5·36*d.*
12. $7\frac{5}{7}$ gall.
13. £186.
14. £399 11*s.* 11*d.*
15. A, £5000; B, £3500.
16. 5 : 2, or $\frac{5}{7}$ and $\frac{2}{7}$.

No. 6.

1. ·2807 −.
2. 23*s.* 4*d.*
3. ·911458 +.
4. 27 ; $\frac{2}{3}$.
5. $3\frac{1}{8}$ yrs.
6. ·0347.
7. $3\frac{3}{7}$ p. c.
8. £10666 13*s.* 4*d.*, £146 13*s.* 4*d.*
9. £56 10*s.* 11·9*d.*
10. $33\frac{7}{9}$ min.
11. £2408 12*s.* 6*d.*
12. 4*s.* $10\frac{1}{2}$*d.*
13. 181·7 +.
14. 5 p. c.
15. 170 and 70 g.
16. $6\frac{2}{3}$, $5\frac{5}{6}$.

No. 7.

1. £3 11*s.* 3*d.*
2. ·7326.
3. 114·966 + lks.
4. ·230912 +.
5. $\frac{5}{31}$.
6. 13*s.* 4*d.*
7. 26 miles.
8. $37\frac{1}{2}$ min.
9. 33060 sq. lks.
10. $17\frac{7}{9}$ yds.
11. 12 miles.
12. £45 12*s.*
13. $17\frac{1}{2}$ and $10\frac{1}{2}$ lb.
14. £184 12*s.* 6·93*d.*
15. £50 and £260.
16. 89 lbs.

No. 8.

1. ·890883 +.
2. £709 10*s.* 11*d.*
3. $\frac{23}{37}$.
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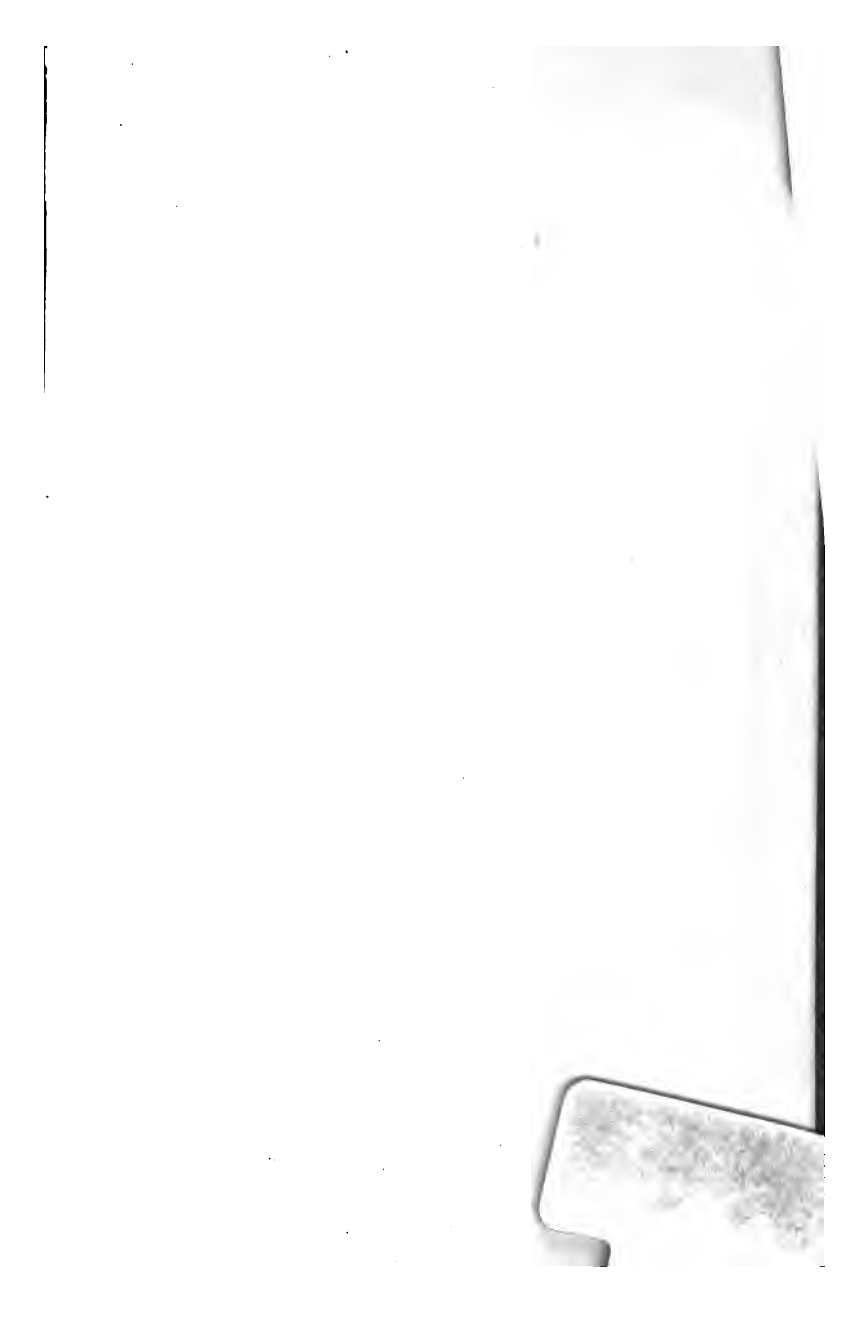
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